DOCUMENT RESUME

ED 171 567 SE 027 787

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TITLE Focus on the Stars.
INSTITUTION Nebraska State Dept. of Education, Lincoln.
PUB DATE 78
NOTE 87p.; Not available in hard copy due to copyright restrictions; Appendix F contains marginal legibility

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Astronomy; Earth Science; Elementary Education; *Elementary School Science; *Intermediate Grades; Learning Activities; Planetariums; *Science Activities; *Science Education

ABSTRACT

This document consists of a series of astronomy activities for intermediate grade students. It contains three major teaching sections. Teacher Section I deals with stars, constellations, and galaxies and presents a series of demonstrations, discussion topics, readings, and hands-on-activities. Teachers Section II is concerned with a planetarium visit. Teacher Section III contains information needed to conduct a night sky watch. Five Appendices include student activities and simplified sky charts. A glossary of terms and a useful bibliography of resources are provided following the entries in the Appendices. (Author/MA)

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FOCUS ON THE STARS

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The cover photo was taken with Kodax X-Plus black and white negative film. The camera was on a tripod focused on the North Star. The zoom lens on a 35mm camera was set at 70mm. The aperture was f-8. The shutter was left open for eight hours on a clear moonless August night from 9:20 p.m. to 5:20 a.m.

The arcs of light are stars that appeared to move because of the Earth's rotation. The bright star making the smallest arc is the North Star or Polaris. Exact north is the vertex of the arcs. Notice the North Star is actually a few degrees from due north but for practical purposes is north. The dots of light that make a trail across the photograph were the blinking wingtip lights of an airplane that flew in view of the camera.

The cover picture was photographed and developed by Kevin Kelley, a teacher at Blair elementary schools.

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FOREWORD

Educational service units have contacted the Department of Education requesting elementary astronomy activities for use with planetariums. As of this date, five educational service units have ordered portable planetariums, and numerous schools in many parts of the state have access to permanent installations. A concern existed that planetarium programs be more than just entertainment.

Due to the obvious expressed need for curriculum materials on this topic, a writing committee was organized. The charge to the writers was two-fold. The first purpose of the publication was to enhance utilization of planetariums by providing pre- and post-activities for teachers and students to facilitate learning during the planetarium program. Secondly, the attempt has been made to assemble activities in such a manner that teachers and students without access to the planetarium can utilize the materials in the form of a regular teaching unit.

It is hoped that these materials are deemed beneficial and are utilized to assist students in their quest for scientific knowledge.

Anne Campbell
Commissioner of Education

PREFACE

"Focus on the Stars" consists of a series of astronomy activities for intermediate grade children. Each year thousands of Nebraska elementary students visit a planetarium. The advent of portable class-sized planetariums and the building of a number of new permanent installations promise to further increase the number of children who have access to a planetarium.

Unfortunately, many students visit planetariums with little or no prior preparation, and in many cases there is little follow-up after the visit. This publication addresses itself directly to this problem. The purpose of the activities presented here is to make the student's visit to the planetarium a more meaningful educational experience. The activities have been developed around basic concepts which are vital to the understanding of the earth-space setting.

A special effort has been made to keep the materials and equipment used in the activities simple and easy to obtain. Most of the materials used are found in the average elementary school. Possible sources are suggested for a few items which may be more difficult to obtain.

Finally, it is the belief of the writers that astronomy concepts are best taught through a series of student-centered activities and everyday experiences.

The writers also wish to express a special thank you to Rosalie Bierle for typing the manuscript, and to Nancy Wipf for preparing the final format of the visuals in the publication.

INTRODUCTION

It is indeed a pleasure to present this publication to Nebraska elementary teachers. I wish to personally thank the other three writers - Joe Pinkall, Kevin Kelly, and Pat Geary for their extensive contributions. Since the four of us provided input throughout the booklet, no effort has been made to give credit for any one activity to a specific writer. It is important to note, however, that Kevin prepared nearly all of the sketches provided in the Appendix handouts. I also wish to thank Dr. Dale Rathe of Lincoln Public Schools and Dr. J. Bruce Holmquist, formerly with Educational Service Unit #3, for their suggestions and input.

This manual has three major teaching sections. Teacher Section I "THE NIGHT SKY" is subdivided into three components: Part I - Stars, Part II - Constellations, and Part III - Galaxies. Section I contains a series of demonstrations, discussion topics, readings, and hands-on activities. Each part has concepts thought important for children to attain with some degree of certainty. In turn, each concept has one or more objectives which can be used to assist in evaluating student progress through the units. These concepts are compiled in a suggested order of events. That is, it is recommended that you proceed beginning with Stars, Concept 1, and teach the unit sequentially. Please note, however, that this is merely a suggested outline. Various teachers may wish to choose only selected concepts or activities and rearrange the sequence to meet individual needs, pupil interests, time limitations, or difficulty of topics.

The student activities are printed in the Appendix Section of the manual. Appendix A has student activities for STARS. Appendix B has student activities for CONSTELLATIONS.

Teacher Section II deals with the topic of "MOTION." It is recommended that a planetarium visit for students be scheduled upon completion of Teaching Section I if possible because of the nature of the section on motion. Appendix C provides an orientation to the planetarium. Most of the student activities for the motion section are long term and, therefore, may be considered as optional for many students. Appendix D contains the student activities for "MOTION."

Teacher Section III "THE NIGHT SKY PARTY" may be the most enjoyable and rewarding project. This experience will be extremely exciting for students and parents alike. The teacher section contains an excellent presentation of information instructing you as to procedures for conducting such an event. Appendix E contains a simplified sky chart with only the ten constellations taught in this unit, plus an evening sky map for each month of the year to enable students to orient their simplified map to the relative position of constellations for that month. A glossary of terms and useful bibliography of resources are provided following the entries in the Appendices.

The learning concepts and activities in the publication offer students numerous opportunities to study the stars in a variety of ways. The student's progress in locating the North Star, identifying a constellation for the first time, or even realizing that stars appear to move across the night sky will surely be a personal victory. This is certainly our goal as a writing committee.

Don Woodburn
Science Consultant
Nebraska Department of Education

TEACHER SECTION I

"THE NIGHT SKY"

PART I: STARS

PART II: CONSTELLATIONS

PART III: GALAXIES

Part I: STARS

CONCEPT 1: The sun is one star in our galaxy called the Milky Way Galaxy.

OBJECTIVE 1: *To understand that our universe is made up of all of the galaxies, the stars, and our own solar system, which includes the sun and its nine planets.*

ACTIVITY 1: Have the students list objects known to be in the sky. Discuss and bring out Objective 1.

ACTIVITY 2: Suggest that students observe the sky on a clear evening and discuss your observations on the following day. You may choose to ditto and distribute Handout A-1 "LOOKING AT THE SKY."

OBJECTIVE 2: *To learn that our galaxy alone, known as the Milky Way Galaxy, is close to 100 thousand light years across. In it are about 100 billion stars, our sun being one.*

ACTIVITY: Predict how many stars are in the Milky Way Galaxy. Record the guesses of the class members and inform them that it is approximately 100 billion. Write 100 billion (100,000,000,000) on the board.

CONCEPT 2: Stars vary in brightness, size, and distance from Earth.

OBJECTIVE 1: *Understand that stars vary in brightness, and this apparent brightness is called Magnitude.*

MATERIALS: Two 25 watt light bulbs, two bulb receptacles, and two extension cords

ACTIVITY: To explain variation in brightness to students, use this demonstration. Take the students into the hallway or gym. Place one bulb halfway down the hall, and place the other bulb at the end of the hall. Ask the students: "Which bulb 'appears' brighter?". Compare this situation to stars. Discuss the variations in the brightness of stars relative to their distance from Earth.

This demonstration can be repeated in many ways. A 200 watt bulb can be substituted for one of the 25 watt bulbs for example. Move the two lighted bulbs up and down the hallway until the class agrees that they are nearly the same in brightness. It should be obvious that the larger bulb can be much farther away while still having the same apparent brightness as the 25 watt bulb.

Again, discuss with the students some of the reasons for the observed differences in brightness of stars. Discuss some of the following questions:

"Are the brightest stars always the biggest stars?"
"Are the brightest stars always the nearest stars?"
"Are there any stars that we cannot see?"

OBJECTIVE 2: *Recognize the myths of many people about stars.*

ACTIVITY: Distribute Handout A-2, "WHAT IS A STAR?". After time for reading, discuss the myths about stars.

CONCEPT 3: The light coming to us from stars is not the light shining today. The light seen now has traveled millions of millions of miles through space and left the stars many years ago.

OBJECTIVE: *Understand that star light seen now left the stars many years ago.*

ACTIVITY: Make a blackboard illustration showing movement of light from stars to the earth. Help students understand that light reaching the earth left the star a long time ago.

Compute the time for the star, Proxima Centauri, our nearest star which is 4 1/3 light years away. Light travels at 186,000 miles per second. There are 60 seconds in a minute, 60 minutes in an hour, 24 hours per day, and 365 days per year. Multiply all of that and then times the distance of 4 1/3. Have fun!

CONCEPT 4: The vast distances in space are often measured in terms of light years.

OBJECTIVE: *Comprehend the vastness of the distance determined by a light year.*

ACTIVITY: Discuss further the concept of a light year with the students. A light year is the distance light travels in one year. Our sun, the closest star, is only 93,000,000 miles away. Therefore, at a rate of 186,000 miles/second, light from the sun reaches Earth in about 11 minutes. Compare this with Proxima Centauri above which is over four light years away. Finally, discuss some of the following interesting facts. The North Star is 50 light years away. Other stars in the Big Dipper are 100 light years away. In winter months, many of the stars we view are 540 light years away. A good math student might attempt to compute the distance in miles from Earth for some of the above situations.

Part II: CONSTELLATIONS

CONCEPT 1: A constellation is a group of stars named for a particular object, person, or animal, or the area of the sky assigned to a particular configuration.

OBJECTIVE: *To recognize that constellations are merely imaginary groupings of stars that are not actually connected in any way.*

ACTIVITY 1: Distribute Handout B-1, "WHAT IS A CONSTELLATION?". After time for reading, discuss objective presented.

ACTIVITY 2: Distribute Handout B-2, "CREATE A CONSTELLATION." Have the students connect the stars in any pattern to form a figure of some type. This will be their "self-discovered" constellation.

Have the students name their constellations. You may want them to compose a mythical story to go with tne figure.

As a class you may want to develop an entire sky map, putting each student's constellation in the sky, and use a bulletin board as your universe.

It is important to develop the concept that constellations are actually only imaginary shapes named in the same procedure as the students have just used.

CONCEPT 2: The North Star (Polaris) acts as a guide for locating many constellations.

OBJECTIVE: *To locate the North Star.*

ACTIVITY: Distribute Handout B-3, "LOCATING THE NORTH STAR AND CASSIOPEIA USING THE BIG DIPPER." Discuss the procedures described in the handout with the students, and ask them to take the handout home and perform the activity.

CONCEPT 3: Of the dozens of visible constellations, ten are easily observable to elementary age children.

OBJECTIVE: *Identify ten of the most recognizable constellations, their locations, and mythological origins.*

PREACTIVITY PREPARATION: The teacher directions below are for the construction of 35 mm slides. It is recommended that you prepare a set of these for large group use. This could be conducted as a student group work activity if you so decide.

A. Opaque Model (This slide will project a constellation on the screen.)

Materials: Aluminum foil, sharp pointed object, 35 mm slide jackets (available at most photography stores), and template (see following page).

Procedures:
1. Cut out the appropriate template provided on the next page.
2. Center it on a rectangular piece of foil that is ¼" larger than slide window on all sides, and punch small holes through template and foil corresponding to each star. NOTE: Have the foil resting on a piece of cardboard or other cushioning surface before punching.
3. Remove the template and insert rectangular foil into the slide jacket. The slide is now ready for normal slide projection techniques.

B. Outline Model (This slide will project a drawing of the mythological character on the screen.)

Materials: Heat-sensitive overhead transparency film, 35 mm slide jackets, and template of outline provided in D.

Procedures:
1. Obtain the appropriate outline template from D. Place on the transparency film in the recommended manner and reproduce onto the film.
2. Cut out the transparency model, allowing margins ¼" larger than the slide window on all sides.
3. Insert cutout rectangle into slide jacket. Black touch-up or the addition of color may be performed to enhance the slide for viewing.

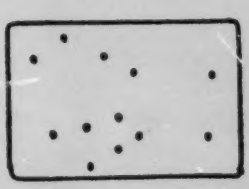
C. Slide Utilization
1. The opaque constellation slides can be projected on a dark chalkboard. Students could go to the board and "connect the stars", to show the imaginary patterns depicted.
2. The outline transparency slides can be projected on the screen as you discuss the mythology of the star groups with the class.
3. The slides can be used in learning centers for review purposes by students throughout the unit.

D. 35mm Slide Templates:

SCORPIUS

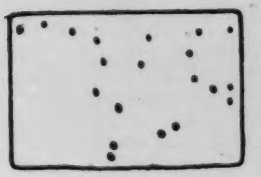
CANIS MAJOR

PEGASUS

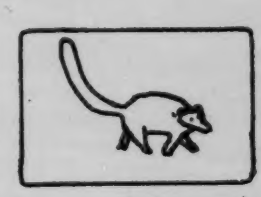


DRACO

URSA MAJOR

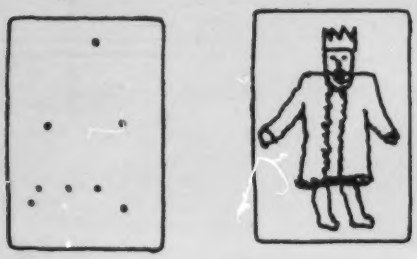


URSA MINOR

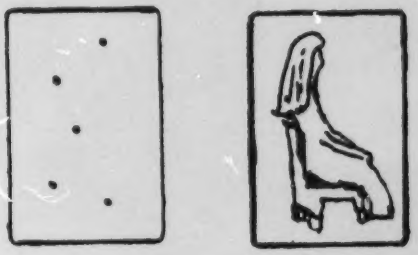


D. 35mm Slide Templates (Continued):

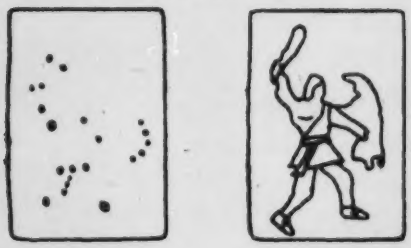
CEPHEUS



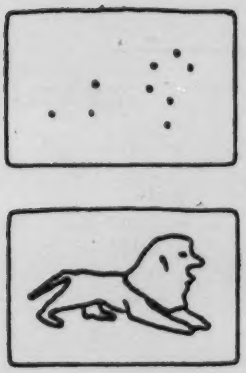
CASSIOPEIA



ORION



LEO



ACTIVITY 1: Distribute Handout B-4 (2 pages), "TEN MAJOR CONSTELLATIONS." Instruct each student to attempt to connect the stars, using a pencil, into the correct pattern. Next, show each correct constellation using the 35 mm template slides prepared for this activity.

Finally, have the students redraw the constellations, in pen, to correctly connect the stars in their proper perspective. (Have the students keep these diagrams in their notebooks.)

ACTIVITY 2: Distribute the 10 Handouts B-5 through B-14. These pages describe the location, configuration, and mythology of each constellation.

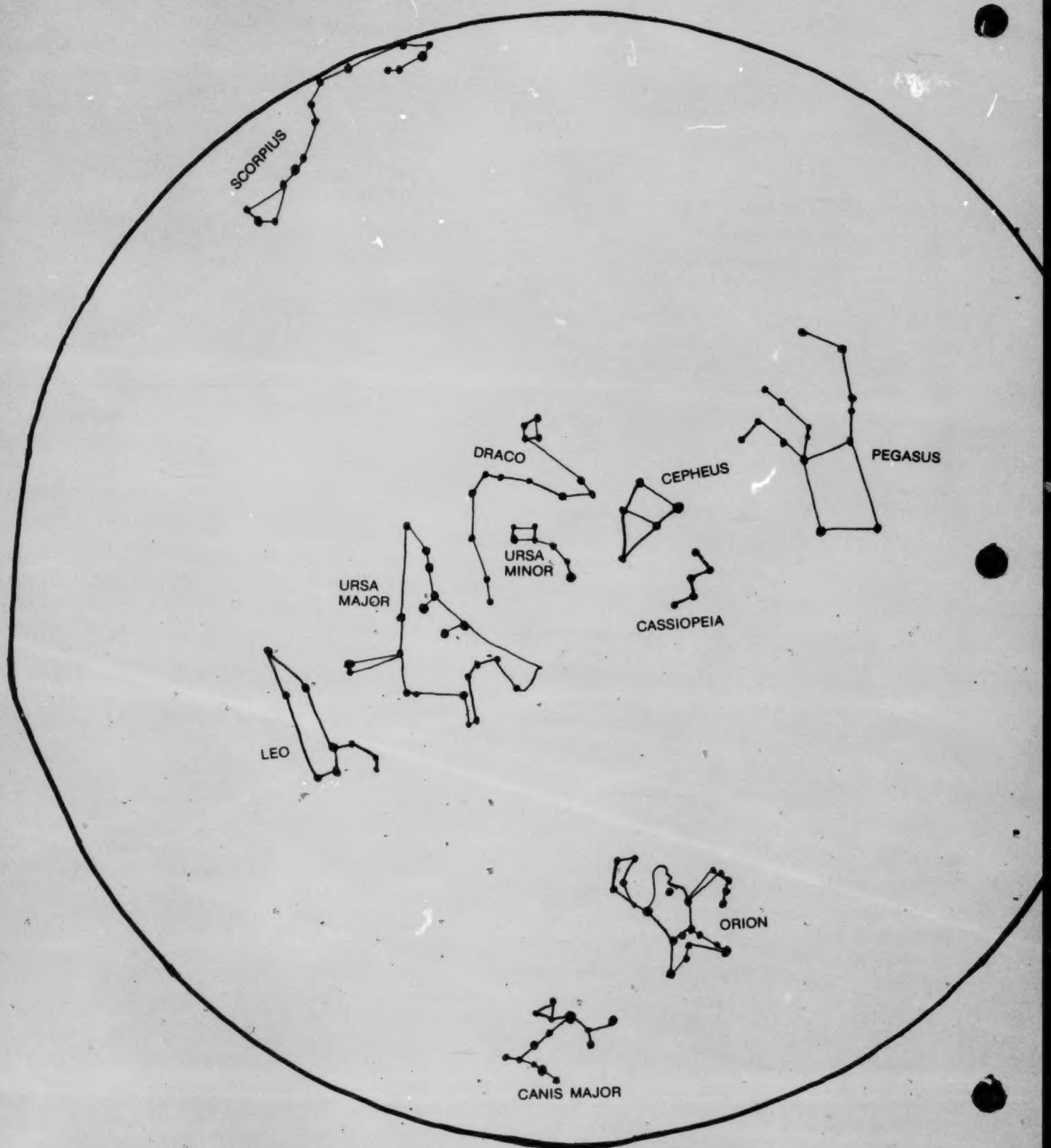
Divide the class into 10 groups, assigning each group one constellation. Have each group report to the class about the location and mythology of their constellation. Since only a brief mythological sketch is provided here, additional research may be necessary.

CONCEPT 3: A star map is a helpful guide to finding the position of a constellation.

OBJECTIVE: *Know how to use a simplified sky map, to locate ten constellations.*

ACTIVITY: Distribute Handout B-15, "SIMPLIFIED CONSTELLATION SKY MAP". Have the students locate or draw in the ten constellations they drew in Concept 2, Activity 1, on this simplified sky map.
NOTE: Please point out to the students that the maps provided are showing only ten constellations of the dozens which are visible.
A teacher key is provided on the next page.

SIMPLIFIED CONSTELLATION SKY MAP
(Teacher Key)



Part III: GALAXIES

CONCEPT 1: A galaxy is a huge cluster of stars, dust and gas rotating around a central hub.

CONCEPT 2: The Milky Way is believed to be a spiral galaxy, and our solar system is located in one of the spiral arms of that galaxy.

OBJECTIVE: *Realize what a galaxy consists of, and which galaxy we are located in.*

BACKGROUND: Galaxies are groups of stars. Galactic clusters are groups of galaxies. If you could map the whole universe, galaxies would be the cities and galactic clusters would be the states. But if you did that, these clusters could be found closer together than cities seem to be grouped in the states. However no one is exactly sure because no one is far enough away to see it all at once. One of the great beauties and mysteries of the universe is that all things - atoms, planets, stars, galaxies, clusters- seem to clump together around some axis or other point of revolution, no matter where they are. NOTE: There is no Appendix Section for Part 3: Galaxies. All suggested student activities are provided here in the teacher section.

MATERIALS: Paper Pencil

ACTIVITY 1: Read the following passage to children. Then have them answer the questions that follow.

Have you ever noticed in the early months of summer, fall, or winter, a hazy white band of light that seems to cross the whole sky? If you have, you have seen a universe of stars or a cluster of stars, which we call the Milky Way Galaxy.

The Milky Way Galaxy is actually shaped like a pinwheel or a spiral. In it our sun is only one of several millions. Just counting on a clear night, one might count as many as 6,000 suns without a telescope. Some of the stars are so small we would have to examine them with a microscope. Our sun is a medium star.

We have to remember that our universe, or galaxy is only one of several million galaxies in space. We can not tell with the use of a telescope if all the suns

have solar systems like our own. Only time and exploration can reveal this.

Student Questions:

a. When is the best time to see a cluster of stars?

b. How many galaxies are there in space?

c. What do we call a universe of stars?

d. How are they usually shaped?

e. At different times on a clear night, how many suns could one count?

f. What size star is our sun?

ACTIVITY 2: Pretend you have never seen a jungle gym before. Crawl to the center of a jungle gym. Try to draw a picture of the jungle gym from the center. What kind of picture have you drawn? What is the jungle gym like? State one reason it is difficult to picture what our Milky Way Galaxy is like.

CONCEPT 3: There are theories about the origin of the universe.

OBJECTIVE: *To know one scientific theory about the origin of the universe.*

BACKGROUND: Do we know how the universe was formed? It would be safe to say "No." No one was there to see it. Some scientists have questioned whether the universe had a beginning. Perhaps it always existed?

More than 7 billion years ago matter in the universe may have been compressing--squeezing together or contracting--rather than expanding. Matter contracted and became very, very dense. Matter that is compressed becomes heated, like the air in a bicycle pump. The early matter in the universe was heated this way to very high temperatures and then exploded. This theory of how the universe was formed is the "big bang" theory. The expanding universe is the result of this gigantic explosion. Soon after the explosion, the chemical elements were formed. Some elements break down or decay to form other elements. Since these elements decay at a steady rate, scientists can study them to estimate the age of the universe. The oldest rocks found on the moon are over 4 ½ billion years old. The universe is estimated to be much older, probably more than 7 billion years old.

Among the products of the great explosion were huge clouds of dust and gas. Scientists think that the great swirls of dust and gas became galaxies. Large swirls may have condensed to form stars. Smaller swirls may have condensed to form planets that revolve around the stars. According to this theory, the Milky Way was formed from a giant cloud of dust and gas. Out of this cloud many smaller clouds were formed, and our own solar system began. One cloud condensed to form the sun. Smaller clouds near the sun condensed to form the planets--one of which is the earth. The moon formed from a still smaller cloud.

MATERIALS: 20 marbles Piece of cloth

ACTIVITY: Pupils can demonstrate the "big-bang" theory. You will need 10 marbles and cloth.

The marbles will be used to represent clouds of dust and gas that make up the universe. The cloth will be used only to keep the marbles from rolling too easily. Lay the cloth on the top of a table or desk, and place about 10 marbles at different places on the cloth. Move the marbles closer and closer together until they are all collected in the center and are representative of all matter in the universe. Push down on the group of marbles so that the marbles move out in all directions. Your push represents the explosion which, according to the "big-bang" theory, took place many years ago. Notice the motion of the marbles. The marbles all seem to be moving away from each other. You know that the marbles eventually will stop moving, even if they fall off the table. According to the theory, however, the galaxies of the universe will not stop moving away from the point of explosion. The "big-bang" theory describes our universe as one formed long ago in an explosion, the results of which are still occurring. The galaxies are moving away from one another with the inference being made that their starting point was the point of the explosion.

CONCEPT 4: Some of the constellations are circumpolar and do not rise or set in the sky; they may be seen on any clear night.

OBJECTIVE: *Illustrate that constellations around Polaris never go below the horizon for people in the northern hemisphere.*

BACKGROUND: Tell the students if they can find five constellations which do not disappear, they are careful observers. Name five* that never set. The stars in these constellations are said to be circumpolar stars since they seem to revolve around the pole star, yet do not go below the horizon.

* (Ursa Major; Ursa Minor; Cassiopeia, the Queen; Cepheus, the King; and Draco)

ACTIVITY: Observe the North Star on your simplified constellation sky map. Examine the constellations immediately around it. Now turn the sky map counterclockwise and discover the constellations around Polaris which never go below the horizon.

Additional Constellation Activity Suggestions

1. Have students form constellation patterns on the playground or in the gym by assigning each student a star position, spacing themselves like constellation groups.

2. Have the students plot the constellations taught in this manual on a 10' x 10' sheet of paper. Suspend the paper from the classroom ceiling. Orient the constellations for this ceiling chart exactly as shown in the circular star chart activity.

3. Assign students who have access to cameras, to try taking photographs of the North Star or various constellations.

4. Suggest to students with access to binoculars that they try to see which star in the handle of the Big Dipper is actually two stars. (This is called a binary star system. The middle "star" of the handle is actually two stars.)

5. Try to see the shadow of your hand on a white surface caused by Venus on a night when there is no moon.

6. Try to determine differences in color of several different bright stars. Look at them through binoculars or a telescope to see if you are correct.

7. Ask interested students to research the brightness (magnitude) of several stars. Ask them to discover what causes the stars to vary in their apparent brightness.

8. Research the American Indian stories that pertain to constellations visible in North America.

9. Research different types of telescopes and present a report to the class about the information retrieved and give a diagram/explanation of how they operate.

10. Some types of telescopes to research: Balloon telescopes, reflectors or refractors, Hale telescope, Newtonian telescopes, etc. Tell how and where each telescope is used. Explain how one is different from another.

11. Prepare an exhibit on the development of telescopes from the time of Galileo to the present. Pupils might construct models of the various types of telescopes.

12. Get a convex and concave lens from an optometrist or from the science department in a senior high school. Feel the two lenses. Discuss the difference. Hold the convex lens in the beam of a filmstrip projector. Chalk dust (clap erasers together) will show the converging pattern of light from a convex lens. Do the same with the concave lens to show the diverging pattern.

13. Look up the meanings of: refract, eyepiece, objective lens, converge and diverge.

14. (Very Optional) Make a telescope - See Astronomy, Examining Your Environment by John C. MacBean and Associates, Holt, Rinehart, and Winston, 1977, pages 65-67

15. Divide students into pairs. Each pair will be one team.

    a. Put the names of the constellations studied into a container.

    b. Give each pair of students a pile of checkers or similar markers.

    c. Have the teams race to form the constellations drawn from the container.

TEACHER SECTION II

"MOTION"

MOTION

Background Information for the Teacher

The earth has two principal motions. Rotation is the turning of the earth on its axis. Revolution is the motion of the earth in its orbit around the sun. Care should be taken not to confuse these terms when working with children. The earth rotates on its axis once in 24 hours (rounded off). When viewed from above the North Pole the earth turns in a counterclockwise direction. It might be less confusing to children if the earth is thought of as turning from west to east. The sun appears to rise in the east. We know that the earth is moving and the sun "standing still." Therefore, we must be moving toward the sun at sunrise or toward the east. It is important to see that sun time varies from east to west because of the earth's rotation. For example, sunrise occurs in Omaha long before it does in Scottsbluff.

When the earth is observed from above the North Pole it appears as a circle. All circles contain 360°; therefore it is 360° around the earth. We know that the earth turns once in 24 hours. By dividing the distance around the earth (360°) by the time it takes for the earth to rotate once on its axis (24 hours) we find that the earth turns 15° per hour. There are 60 minutes of arc in one degree. There are 60 minutes of time in one hour. Therefore, we may also say that the earth turns one minute of arc each minute of time. It is extremely important for children to realize that the apparent night motion of the stars is due to the earth's rotation, not the stars moving! Think of the stars as being stationary in space. What will a star on the eastern horizon appear to do as the earth turns toward the east? Obviously it will appear to rise. Following the same logic, it is apparent that the North Star will not appear to move since it is over the axis of the earth. The stars which are near the North Star will appear to circle it since they are seen too far above the horizon to rise and set.

The rotation of the earth can be demonstrated by using a long pendulum. This experiment was first performed publicly by the French physicist, Foucault, in the early 1850's. A large iron ball was suspended from the dome of the Pantheon in Paris by a wire about 200 feet long. Once put in motion a pendulum will continue to swing in the same direction, that is, toward some object in space. Foucault's pendulum appeared to move slowly in a circle in a clockwise direction. The earth was actually turning under the invariable pendulum swing! An understanding of the motion of the Foucault pendulum motion helps to understand Coriolis effect so evident in the winds, ocean currents, rotation of air masses, etc.

Background Information for the Teacher (continued)

The movement of the earth around the sun is called revolution. The earth revolves about the sun in approximately 365¼ days or one calendar year. While the earth is revolving around the sun its axis points toward the North Star (Polaris). Since the axis angle never changes, the angle between the earth's axis and the sun is constantly changing; giving us our seasons and causing changes in the stars which are visible.

The yearly changes in the stars which are visible are sometimes difficult for children to understand. Remember that it is night when we are on the side of earth away from the sun, and we can only see those stars which are above us at night. Consider two times of the year; six months apart; -- for example, December 21 and June 21. The earth is on opposite sides of its orbit on these two dates. When you look into the sky on these two nights you are looking in opposite directions and see a different part of the sky. Therefore, the stars seen in the southern sky will change throughout the year. For the same reason the stars which are near the North Star will appear to make a complete circle around it each year.

In order to determine motion it is necessary to have reference points. There are a number of reference points which are frequently used in astronomy. These can be easily understood if one visualizes a model in which the earth is surrounded by a transparent sphere to which all the stars are attached. The point on the transparent sphere directly above the North Pole is called the North Celestial Pole. The point which is directly above the South Pole is the South Celestial Pole. The projection of the earth's equator on the transparent sphere is called the celestial equator. The path which the sun and planets follow across the transparent sphere is known as the ecliptic. The 16° wide band on the transparent sphere where the twelve zodiacal constellations appear is called the Zodiac. Imaginary lines which run from the North Celestial Pole to the South Celestial Pole and correspond with longitude meridians on earth are called Right Ascension Lines. Imaginary lines around the transparent sphere which are parallel to the celestial equator and correspond with latitude parallels on earth are called Declination Lines.

CAUTION: Remember that the explanation above is a model which helps us study the stars; it is not a model of what we think the universe is like.

CONCEPT 1: Polaris seems to stand still while the other stars seem to revolve around it.

OBJECTIVE: *Understand why the North Star does not change position in the sky.*

MATERIALS: Globe Keyhole Flashlight

ACTIVITY 1: One student should turn the globe representing the earth while someone else holds a lighted keyhole flashlight representing the North Star a few feet above the North Pole. The "North Star" seems to remain in the same position as it would be viewed from the "earth." Next, let the flashlight represent another star--one not directly over the North Pole. As the "earth" rotates, the latter "star" will seem to change position as viewed from the "earth."

CONCEPT 2: The apparent motion of the stars results from the rotation of the earth on its axis.

OBJECTIVE: *Observe and illustrate apparent star motion across the heavens.*

ACTIVITY 1: On the next clear night, assign students to choose four different stars to watch. Observe their positions three different times at least 30 minutes apart. (Use the same point of reference such as a television antenna each time.) Report your findings considering the amount and direction of movement. Speculate as to how that compares to the movement of the sun for the same length of time it is overhead.

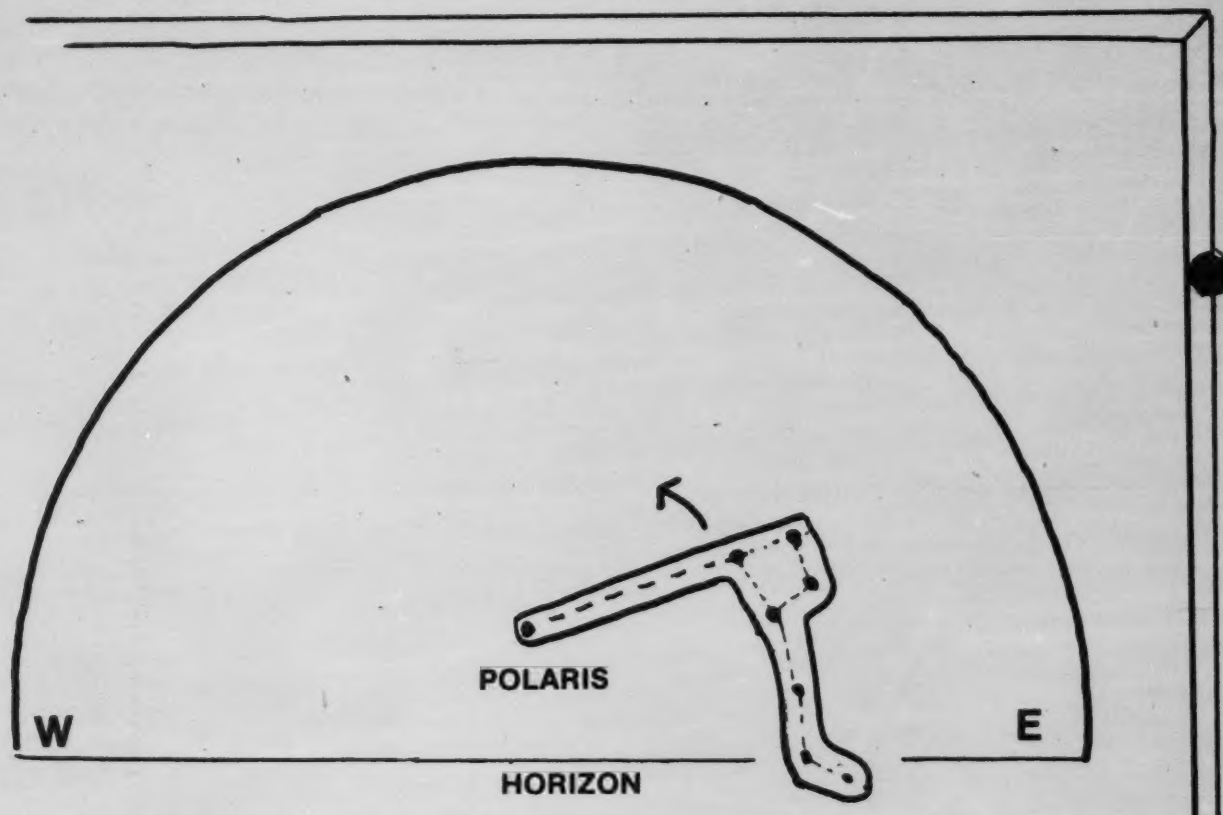
ACTIVITY 2: Distribute Handout D-1, "THE BIG DIPPER IS A MOVER".

Review with the students the procedure for locating the Big Dipper and using the pointer stars (the two stars at the end of the cup) to locate the Pole Star (Polaris).

Have the students, at home on a clear night, locate the Pole Star and the Big Dipper. Do this initial activity at an hour that is just dark enough so as to find them. Have the student record in pictorial diagram the relative location of each, putting Polaris in the middle of the diagram and showing the horizon. Be sure the student observes the placement from the same location each time. Repeat the observations each hour for a minimum of four hours. Record the location changes on the original diagram.

In class, have the students discuss their results.

ACTIVITY 3: This activity is to be done after students have completed Activity 2. On the bulletin board, construct a large sky dome, labeling the ends of the horizon East and West in their appropriate locations. Construct a one-piece model of the Big Dipper with attaching rod to the Polaris star. Using the center of your sky dome as the location for Polaris, attach it as you would the center of a clock. The Big Dipper should now be able to be moved around the sky dome with Polaris as its axis. Have the students come up and show the results of their investigation in Activity 2. You may want to pick a random location and have the students predict the time the arrangement would probably be observed in that location. See the example below:



CONCEPT 3: At sunset different stars at different seasons can be seen because the earth revolves around the sun. Only at the equator can all stars be seen within the span of a year.

OBJECTIVE: *To develop an understanding of the seasonal changes in stars due to the earth's revolution around the sun.*

ACTIVITY 1: Observing nightly motion is best accomplished during the winter when nights are long. Locate a known zodiac constellation which is near the eastern horizon at about 8:00 p.m. Find the same constellation in the early morning before sunrise. Record your observations.

Discussion Questions:

1. What happened to the constellation during the night?
2. What direction did the constellation move?
3. Is the movement of constellations in the same direction as the sun's movement?
4. Why does the sun appear to rise and set? Did the constellation you observed follow a similar pattern? If so, why?

ACTIVITY 2: Observing yearly motion is a long term activity which requires observations which are made about one month apart. No equipment is required. Since students make the observations on their own the teacher should remind them to make their observation when the proper time arrives.

Pick two known zodiac constellations in the fall, shortly after school starts. Pick one constellation which is in the eastern sky and one which is in the western sky. Observe the position of these constellations once a month for three or four months. Record student observations for future reference.

Discussion Questions:

1. Did the constellations appear at the same place in the sky each night?
2. What, if any, changes did you observe?
3. If the position of the constellation changes, what direction did it appear to move?
4. How long do you think it will be before you see the constellation in its original position?
5. What caused the constellation to appear to move?

CONCEPT 4: Some planets are observable with the naked eye, and their apparent motion can be noted.

OBJECTIVE: *To develop an understanding of reference points used in locating and describing the position of celestial bodies.*

ACTIVITY: Observing planetary motion is a long term activity which is carried out over several months. It requires no equipment. The teacher should assign the student to make the observation during a time period when the planet is visible.

Begin your observations when one of the bright planets is overhead. Observe the planet every two weeks for about two months. Make your observation at the same time each evening. If possible, identify the constellation in which the planet is found and note the position of the planet within the constellation. Also, note how high above the horizon the planet is. Be sure to record your observations for future reference.

Discussion Questions:

1. Did the planet you observed appear in the same constellation each time you observed it?

2. Did the constellation appear the same distance from the horizon each time you observed it?

3. If you observed movement, in what direction was it?

4. The word planet means wanderer. Why do you think the ancient observers gave planets this name?

CONCEPT 5: The zodiac constellations form a circle or "belt," around earth which coincides with the path of the sun.

OBJECTIVE: *Recognize that different zodiac constellations appear to move across the sky so that different constellations are visible during different seasons.*

BACKGROUND: Have you ever noticed that as each month passes a new constellation appears in the sky? Ancient observers were the first to notice this belt of constellations. Everything moves in a path as a yearly occurrence across the sky.

These ancient observers would be strange in appearance to us. They usually wore long robes and tall pointed hats. However, their work was very worthwhile. They studied this path or belt of constellations in the area of the sky that the sun passes through in a year and gave it the name of the ecliptic. The observers also noticed that on each side

of the ecliptic belt, there was a regular procession of twelve groups of stars. Each took on a special meaning in the imagination of the observer. It reminded them of animals and people. Therefore, the circle of animals was given the name, Zodiac.

ACTIVITY 1: Draw or find pictures of the 12 zodiac constellations. Put them on the bulletin board, or on your paper in the order in which they form a circle or "belt" around Earth.

ACTIVITY 2: Make a list of major constellations. Have a partner identify the constellation and the other partner decide whether it is in the zodiac or not.

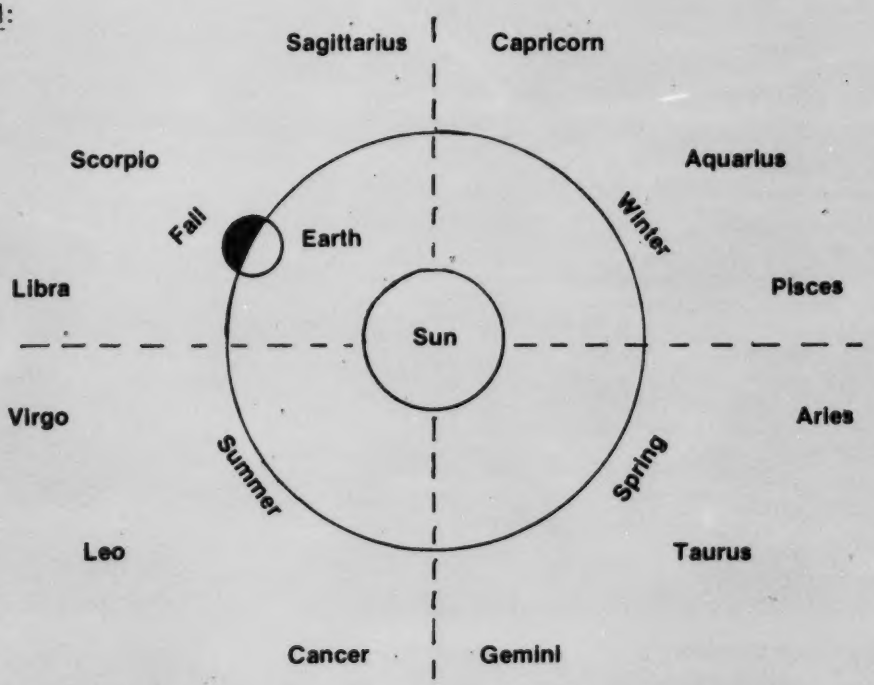
ACTIVITY 3:

MATERIALS: 12 sheets of white paper globe unshaded light bulb

Procedures:

a. Have students copy the 12 signs of the zodiac on large sheets of paper.
b. Arrange the cards in a large circle around an unshaded lamp.
c. Place a clump of clay on Nebraska, to represent the student location.
d. Move the globe around the light simulating the earth's orbit.
e. Record and discuss each of the zodiac constellations observable in each season.

DIAGRAM:



NOTE: In addition to the resources listed in the bibliography, an excellent set of classroom activities is found in the materials entitled "Daytime Astronomy", a unit in the ESS (Elementary Science Study) materials. These materials are available from Webster Division, McGraw-Hill Book Company, Manchester, Missouri 63011

TEACHER SECTION III

"NIGHT SKY PARTY"

NIGHT SKY PARTY

CONCEPT: Stars, planets, constellations, motion and galaxies are observable in the night sky.

OBJECTIVE 1: *To give the students the opportunity to view celestial bodies through a telescope.*

OBJECTIVE 2: *To give the students practice in finding constellations, the North Star, and planets visible to the naked eye.*

OBJECTIVE 3: *To observe the apparent motions of the heavens.*

Background Hints:

You may wish to review with students the activities taught in Sections 1 and 2. Discuss the location of the ten constellations presented and review any planets that are observable during the month of your sky party.
It may be advisable to laminate the best 3 or 4 student notebooks to have available as reference guides for students needing help in orienting themselves during the sky party. These will be especially helpful to curious parent helpers also.
Distribute Handout E-1 (from Appendix E), "SIMPLIFIED STAR CHART", and also distribute a copy per student of the *Monthly Evening Skies* appropriate for the month you have scheduled your class sky party.

General Description of Activity

The sky party is an activity which translates theory into practice. It gives students a chance to study the stars and other celestial bodies in an informal setting. The sky party also affords the rare opportunity to involve parents directly in the learning process. As with any outside school activity, pre-planning and organization are the key to a successful sky party experience. The general activities of a sky party usually include both telescope and naked eye observations. The moon, visible planets, binary stars and possibly galaxies can be included in telescope activities. The identification of the major constellations, the North Star and naked eye planets are usually included in the non-telescope activities. The apparent motion of the stars is also easily observed.

General Considerations

The most important consideration must be student safety. Be sure to check your viewing site in advance, for hazards such as nearby highways, railroad tracks, high banks, water, barbed wire fences, etc.

Discuss general safety with the children and emphasize the appropriate warnings specific to the area you have selected.

Your school district will have rules for this type of activity. Many school districts will require student permission slips. Be sure to work with your principal. If possible, involve the principal in the activity. If your school has an outdoor education program which involves your students, you might consider including a sky party as one of the activities. Each situation will be different; however the following guide lines have been successful for the writers.

1. Make the activity completely optional.
2. Make the parents responsible for bringing and picking up the child. Encourage the parents to stay and look through the telescopes. Parents are usually as interested as children.
3. You may want to have a drink and cookies. It is best to have parents be responsible for food since you will be busy with other activities.
4. Be aware of the weather. Instruct the children to dress appropriately.
5. Establish a procedure to cancel in case of bad weather. For instance, if it is cloudy at 7:00 p.m. the sky party is cancelled.
6. Be sure you have one adult per telescope. Never leave a telescope unattended. If the children don't knock it over, the wind will!
7. Be sure to provide a stool or something for the shorter children to stand on. Many will be too short to look through the telescope when looking at objects near the horizon.

Identifying Available Resources

The first problem will be to locate telescopes and resource people. Begin with your Jr./Sr. High science teachers. Most high school science teachers have some knowledge of astronomy. This may also be your most readily available source of a telescope. The science teachers may also be able to help you or identify amateur astronomers who might be willing to assist you. If your town has a college, you might contact the Physics and Astronomy teachers. They will probably be able to put you in contact with members of Astronomy Societies, or they themselves may be willing to assist. There are several astronomical societies scattered throughout the state. Members of these groups are usually very willing to provide input. In many cases they will even bring their own telescopes. Don't forget the parents of your students. While you may not be fortunate enough to have a child whose parent is an amateur astronomer, you might be surprised at the background some parents have.

Selecting A Viewing Site

If you are lucky you may be able to hold a sky party on your school ground. Check to be sure you have a clear view of the western horizon. Mercury vapor lights are a problem. Try to select an area as far as possible from yard or street lights which can't be turned off. If your school is unsuitable, try a nearby park or field. If you plan to use private property, be sure to get permission! Remember, a high spot with no lights and a good western view will be the best.

Selecting A Time

There are several things which should be considered in selecting a time. Obviously, you can't begin until dusk. When planning in the spring, remember the days are getting longer, and daylight savings time may be in effect. You also won't want to keep the children out too late on a school night. About an hour is long enough. Planning during the right moon phase is extremely important if you plan to view the moon. The best time is one or two days after the new moon. The moon will be in good position to view and not too bright to look at. Anytime before full moon will work, but the detail on the moon will be harder to see later; and a filter may be needed to block some of the light. Remember that the moon rises about 50 minutes later each day, so viewing after full moon is usually impossible.

Sometimes there is literally nothing to look at other than the moon. Try to plan so there will be at least one planet to look at. The viewing time for planets can be found in such journals as *Science and Children* or *Sky and Telescope*. You can also determine viewing time for planets using an inexpensive star finder such as the one published by the Edmund Scientific Company (See Bibliography for address).

Procedure

The following procedure has been used with success by the staff of the Educational Service Unit #3 Science Center in Omaha, to conduct sky parties for area schools. It works quite well for groups of up to 60 or 70 people. Their experiences may serve as a general guideline to help you conduct your sky party.

1. Set the telescope up just before dark. Decide what you will be observing with each telescope if you have more than one available. Be sure the person in charge of the telescope knows how to make adjustments for the earth's rotation, as the sky party activities progress.
2. Point each telescope at a different object--the moon, Venus, Saturn, Jupiter, the binary star in the handle of the Big Dipper, etc.
3. Divide the children into as many groups as you have telescopes plus one group for naked eye observations. Rotate groups until all the children have looked through each telescope and made naked eye observations. Have the adult in charge of each telescope explain to the children what they are looking at. Be sure they see the object with their naked eye as well as through the telescope.

   CAUTION: Finding objects with a telescope is much harder than you think! If you are not experienced, become proficient before the sky party. This may take three or four evenings of practice.

4. If you have only one telescope you will have to switch the telescope from object to object. This means lines will be long. It is not advisable to use one telescope with more than 15 to 20 children. If you have only one telescope and a large class, you may have to schedule sky parties on two nights and divide the students into two groups.

APPENDIX A

STARS

Name_____

HANDOUT # A-1 "LOOKING AT THE SKY"

1. Is the moon out? Yes_____ No_____
   If the moon is out draw a picture of it here.

2. Can you find the direction west? (Look in the direction where the sun sets!) What do you see when you look west? Draw a picture here.

3. Look straight up. Do you see stars? Draw a picture of them here.

4. Look around the sky and find an interesting group of stars. Draw one or two of them here.

5. Are all of the stars the same color? Yes_____ No_____
If not, what colors did you see?

_____

_____

_____

6. Do you notice any stars twinkling? Yes_____ No_____

Name_____

HANDOUT #A-2 "WHAT IS A STAR?"

Before studying constellations, the beginning astronomer must first understand the nature of a star.

Many wrong ideas exist about the stars. One incorrect idea is that all stars are white. By looking closely, one can observe the different colors of some stars. The star Beteljeuse, in the constellation Orion, and the star Antares, in the constellation Scorpius, are giant red stars thousands of times bigger than our sun. To see color, look closely and for a long time.

Another incorrect idea is that stars twinkle. Stars appear to twinkle because of the millions of dust particles which interrupt the light as it passes through the Earth's atmosphere. The Apollo astronauts noted as they passed through space beyond the Earth's atmosphere that the stars do <u>not</u> twinkle.

Many people believe that a star has existed forever and will always exist. Actually stars have a beginning and an end. Instead of existing for hundreds of years like some trees, stars exist for billions of years. Our sun, the closest star, has two to five billion years left before it burns out.

Stars vary in apparent brightness because of differences in size, temperature, and distance from Earth. The sun is by far the brightest star because it is so close to the Earth. But if the sun were placed farther away from Earth among other stars, it would seem dim. The brightest star, Sirius, is farther away than Alpha Centauri A, the closest star other than the sun. Yet Sirius is much bigger and brighter in appearance than Alpha Centauri A.

The star Deneb, in the constellation Cegnus the Swan, is large; and is one of the very brightest stars. But it is so far away that it is hard to tell it is the nineteenth brightest star in the sky. Deneb is so far from Earth that it takes the light 1,400 years to reach the Earth.

Many people have observed a sudden brief streak of light when looking at the night sky. Early astronomers called these "falling stars" or "shooting stars." Today, we know that these are not really stars. These are actually rocks and dust particles floating in space. When one enters the Earth's atmosphere, it becomes very hot and usually burns up. The light seen from this burning is called a "shooting" or "falling" star. A rock the size of a walnut burns with the brightness of the brightest star when entering the Earth's atmosphere. Usually these rocks burn up before they hit the Earth's surface. Occasionally, one does hit the Earth and sometimes causes minor damage. You may want to look in the library for more information about these <u>meteors</u>, as they are scientifically named.

APPENDIX B

CONSTELLATIONS

Name_____

HANDOUT #B-1 "WHAT IS A CONSTELLATION?"

If you have ever solved a dot-to-dot puzzle, or looked for shapes in the clouds on a partly cloudy day, then you could easily invent a constellation. The star patterns that are seen in the clear night skies today, have changed little in thousands of years. The first known science on earth was star-gazing. The earliest cave drawings have star groups in them.

Throughout history people have looked for shapes and signs in the stars. Mothers and fathers would tell daughters and sons the stories of the shapes, and the stories became popular. Soon, many people associated the same story with a group of stars. A group of stars became known as a constellation.

The Greeks and Romans were the authors of most of the constellations that we look at and read about. Scientists today also use the constellations to map the sky. In the days before television and electric lights people passed the time away by looking into the sky. They really used their imaginations to see the shapes that the constellations are named for. Much of the detail was added by imagination, not by any star in the sky.

When looking at the constellations on the handouts provided, try to become familiar with the general shapes. Like people of long ago, add the detail to the constellations by using your imagination. For example, the legs and face of the constellation "Leo", must be imagined because there are no stars that represent them.

Many beginning astronomers observe too small an area when looking for a constellation. Instead, you must look at a very large area of the sky for the shape of a constellation. For example, the Big Dipper occupies a large part of the night sky, but is only a small part of the constellation, Ursa Major, of which it is a member.

Name_____

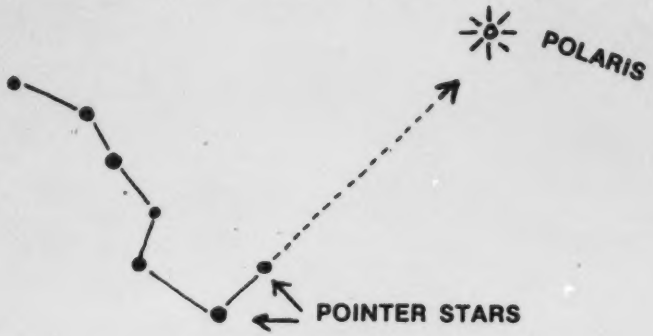
HANDOUT #B-2 "CREATE A CONSTELLATION."

Name_____

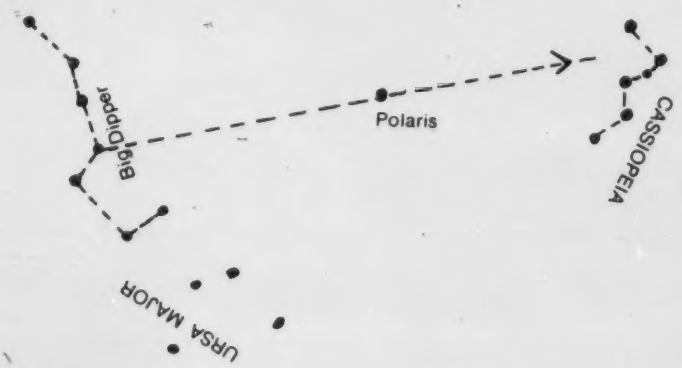
HANDOUT #B-3 "LOCATING THE NORTH STAR AND CASSIOPEIA (KASS-EE-OH-PEA-UH) BY USING THE BIG DIPPER."

The easiest place to begin a study of constellation location and identification is with the North Star, also called Polaris. Polaris is not especially bright, but it is one of the easiest stars in the sky to locate.

On a clear night stand outside and face the northern horizon. First find the "pointer" stars that make up the outer side of the bowl of the Big Dipper. Then follow the imaginary line joining them until you come to the nearest moderately bright star. The distance between the last star in the Big Dipper and the North Star is 5 times as long as the distance between the two "pointer" stars of the Big Dipper's cup.



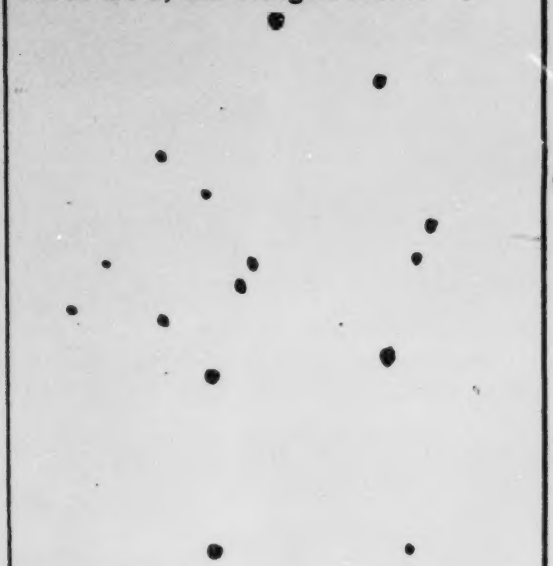
Next locate the constellation of Cassiopeia, shaped something like a "W" with its five brightest stars. Start again from the Big Dipper, but this time from the star that joins the bowl and the handle. Again draw an imaginary line from this bowl-handle star through Polaris and on beyond Polaris for about 5 additional "pointer star" lengths, and you will find Cassiopeia. Now, you have the key features of the northern sky.



Name_____

HANDOUT #B-4 "10 MAJOR CONSTELLATIONS."

PEGASUS, the Winged Horse



ORION, the Hunter

URSA MAJOR, the Big Bear

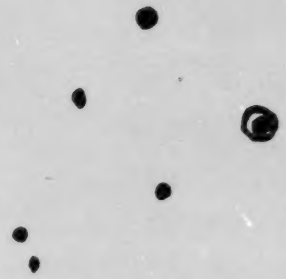
URSA MINOR, the Small Bear

Name_____

HANDOUT #B-4 "10 MAJOR CONSTELLATIONS" PAGE 2

SCORPIUS, the Scorpion

CEPHEUS, the King



CASSIOPEIA, the Queen

LEO, the Lion

DRACO, the Dragon

CANIS MAJOR, the Big Dog

Name_____

HANDOUT #B-5 "URSA MAJOR"

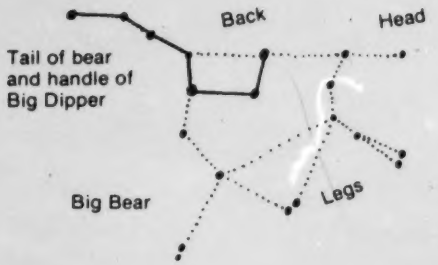
Ursa Major, the Big Bear, is one of the Circumpolar Constellations. Within Ursa Major is the most common star grouping, the Big Dipper. Ursa Major, including the Big Dipper, can be seen throughout the year in the northern sky.

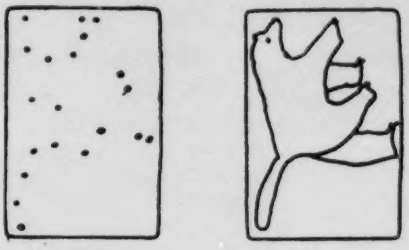
In the winter Ursa Major is in the northeastern evening sky. The tail of the bear (which is the handle of the Big Dipper) appears to be sticking into or pointing at the ground.

In the spring the Big Bear reaches its highest point in the evening sky. The Big Dipper is said to lose its water in the spring, because of the way it is tipped.

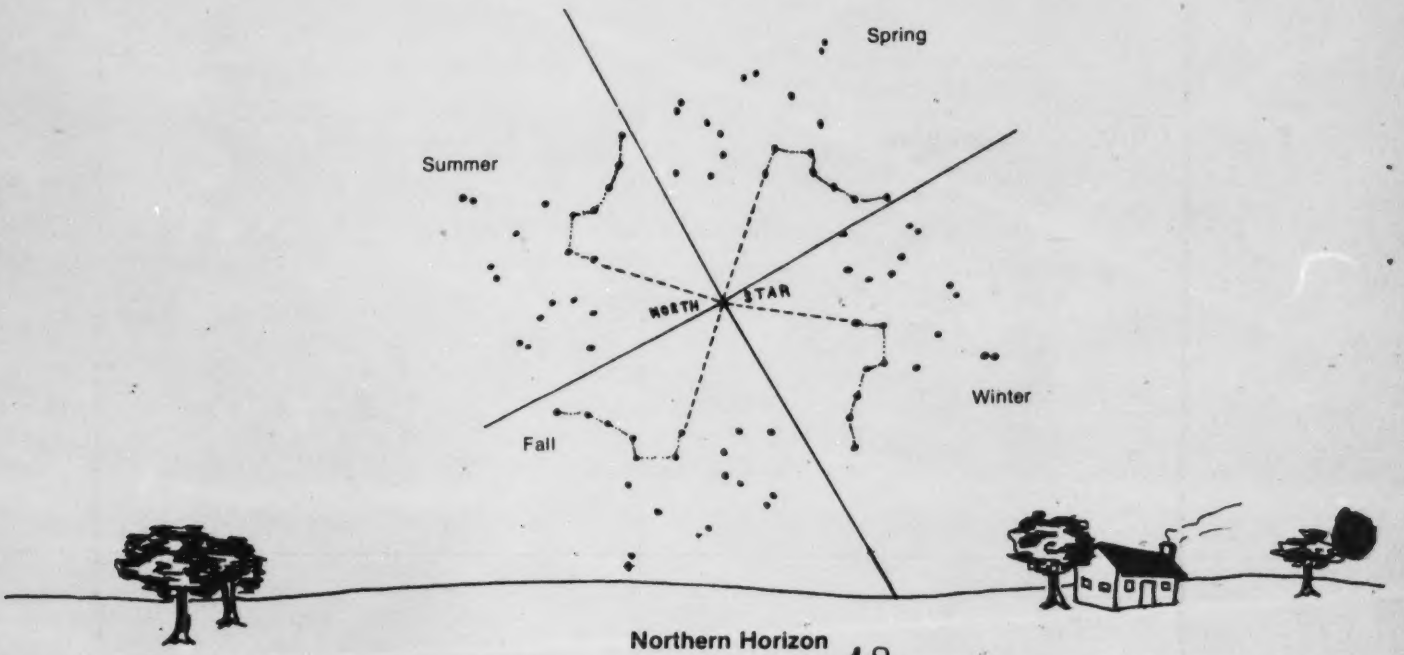
The summer evening skies find the Big Bear in the Northwest with the tail of the bear pointing up in the sky.

In the autumn part of the bear is not visible, and the Big Dipper sits upright on the northern horizon, and is said to be holding water.





Seasonal Positions of Ursa Major with Big Dipper



Name_____

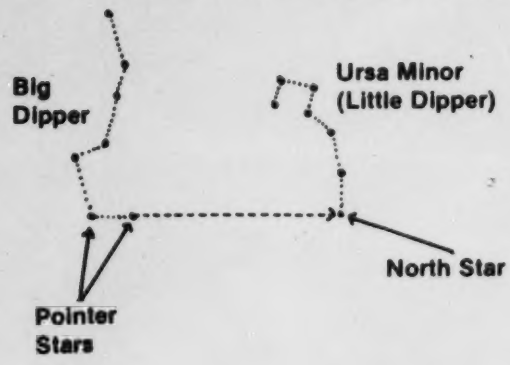
HANDOUT #B-6 "URSA MINOR"

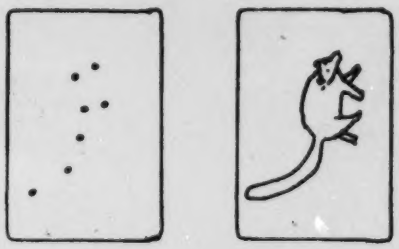
Ursa Minor, the Small Bear is also a Circumpolar Constellation. It can be seen throughout the year in the northern sky. Ursa Minor is also called the Little Dipper. The tail of the Small Bear is the handle of the Little Dipper, and the body of the bear is also the cup of the Little Dipper. The end star of the tail of the Small Bear is also called Polaris or the North Star. The North Star is almost directly over the North Pole of the Earth. From Earth it appears to remain in the same place while the other stars revolve around it.

Find Ursa Minor by first finding the North Star. Two pointer stars will help to locate the North Star. The two pointer stars are the two end stars on the cup of the Big Dipper.

Draw an imaginary line through the two pointer stars starting at the bottom of the cup. Extend the line five times farther than the length between the two pointer stars. There you will find the North Star. Look close by the North Star to complete the shape of Ursa Minor.

Big Dipper and Ursa Minor in Summer Position





MYTHOLOGY OF URSA MAJOR AND URSA MINOR

In mythology, it is stated that Jupiter favored multiple marriages; Juno did not, and promised to punish all of his wives. Callisto was a beautiful wife who bore Jupiter a son, Arcas. Juno punished Callisto by changing her into a bear, and making her roam forever in the forest. One day Arcas went hunting and was about to kill a bear when Jupiter realized Arcas was about to kill his own mother. Jupiter then turned Arcas into a small bear and put both bears in the sky. Ursa Major (the mother bear) is forever pointing toward Polaris. Polaris is the major star in the constellation representing her son (the little bear). Juno had the last word. She went to Neptune, the god of the seas, and asked that the great bear never be allowed to set into the sea horizon. In certain northern latitudes the Big Dipper never sets below the horizon.

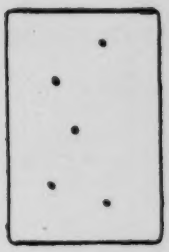
Name_____

HANDOUT #B-7 "CASSIOPEIA, THE QUEEN"

Cassiopeia (Kass-ee-oh-pea-uh) is located on the opposite side of the North Star from the Big Dipper. Cassiopeia is as far from the North Star as the Big Dipper is from the North Star. Just draw an imaginary line from the Big Dipper to the North Star. Extend that line twice as far, and there will be Cassiopeia.

Cassiopeia is nicknamed the Lazy W. Find the "W" in the sky, and you have found Cassiopeia. Use your imagination to find Cassiopeia, the Queen, sitting in her throne.

Cassiopeia can be found high in the autumn evening skies. In summer, Cassiopeia is located in the Northeast and in the winter, she is found in the Northwest.



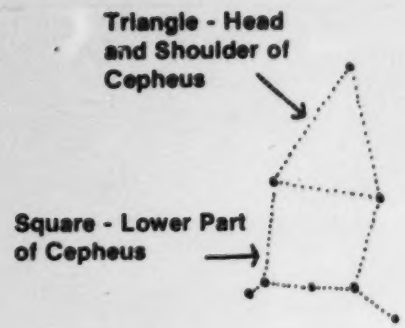
MYTHOLOGY OF CASSIOPEIA

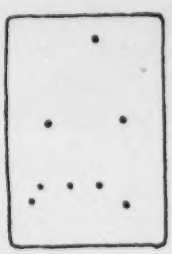
Some say that the "W" is the lighthouse in the sky to guide you to the other constellations. Cassiopeia, the Queen, was the wife of Cepheus, the king of Ethiopia and the mother of Andromeda. She was very conscious of her great beauty and boasted that she was lovelier than Hera, Zeus' sister and wife. This made Neptune angry so he ordered that Cepheus and Cassiopeia chain their daughter, Andromeda, to the rocks. Neptune sent a sea monster to devour her. Perseus, the hero, rescued Andromeda and killed the monster. Cassiopeia now hangs upside down in the sky half the year as punishment for her vanity.

Name_____

HANDOUT #B-8 "CEPHEUS, THE KING"

Cepheus (sē'-fūs), the King, is located close to his queen, Cassiopeia, in the northern sky. The top side of the "W" of Cassiopeia points to Cepheus. The stars of Cepheus are not very bright, so look closely. Two shapes are distinctive in Cepheus. The constellation is made up of a triangle and a square put together. The triangle represents the top portion of the king including his shoulders and head. The square symbolizes the body and legs of Cepheus. In the summer Cepheus is upside down in the northeastern evening skies. In the evening skies of winter, Cepheus is right side up in the Northwest. Cepheus is high in the autumn evening skies and low in the spring evening skies.





MYTHOLOGY OF CEPHEUS

Cepheus seems to be standing behind Cassiopeia with arms outstretched as if puzzled. He is wondering if he should chain Andromeda to a rock.

Cepheus is also said to look like a house located between Cassiopeia and the head of Draco.

Cepheus was the Ethopian King of Joppa, and Cassiopeia was his queen. Cassiopeia was known throughout the world for her striking beauty. Cepheus and Cassiopeia had a daughter named Andromeda. She grew to be as beautiful as her mother.

Cassiopeia bragged widely of her own and Andromeda's great beauty. She claimed to be more beautiful than the nymphs of the sea. Upon hearing this the nymphs complained to Poseidon, god of the sea. Poseidon sent a sea monster and flood to devastate the country. Cepheus found the only way to satisfy the monster was by sacrificing Andromeda.

Andromeda was chained to a rock by the sea, and the sea monster approached. Cepheus and Cassiopeia looked in horror from the shore. Perseus, having winged sandals, flew by and noticed what was happening. He saw Andromeda and immediately fell in love with her. He went to Cepheus and Cassiopeia and said he would save Andromeda and kill the sea monster if he could marry Andromeda. Cepheus and Cassiopeia reluctantly agreed.

Perseus took out a sickle and set upon the monster. The battle ended when he cut off the monster's head.

When he returned to shore Andromeda had already made plans for the wedding. The couple were married, and the festivities began. In the middle of the celebration an army of soldiers led by King Agenor invaded the city. King Agenor claimed Andromeda should marry him. Cepheus and Cassiopeia sided with King Agenor against Perseus. Andromeda loved Perseus and wanted to stay with him.

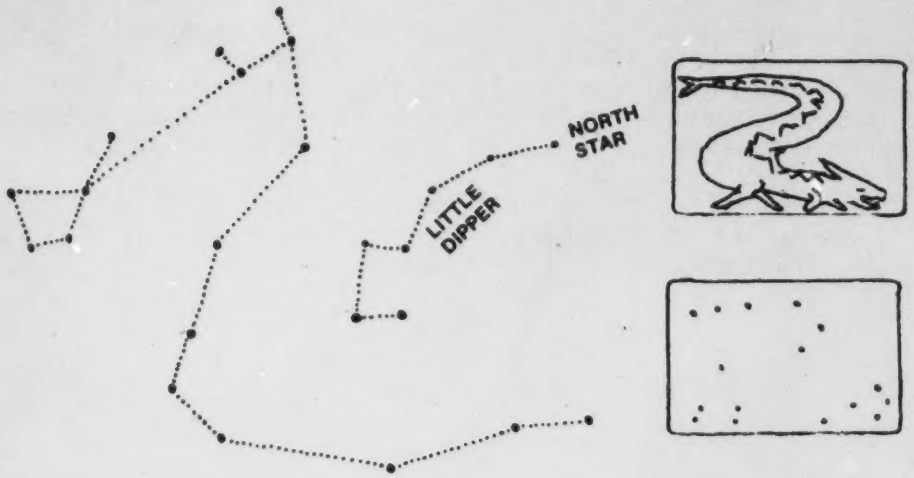
Perseus began to do battle with the army. He did well for awhile, but there were too many. Earlier Perseus had captured the Gorgon's head which had the power to turn anyone to stone if they looked in its eyes. Perseus took out the Gorgon's head and turned all his opponents to stone, including Cepheus and Cassiopeia. Perseus and Andromeda immediately left for Greece and lived happily ever after.

Poseidon placed Cepheus and Cassiopeia in the northern sky. As punishment, Cassiopeia is placed in a market basket which turns upside-down half of the year. She looks ridiculous with her legs and head hanging out of the basket. Cepheus is standing beside her in the night sky.

Name_____

HANDOUT #B-9 "DRACO, THE DRAGON"

Draco (Drā'-kō), the Dragon wraps its long tail around Ursa Minor in the northern sky. The stars between the Big and Little Dippers are the end of the dragon's tail. The tail curves half-way around the cup of the Little Dipper. The main body of the dragon begins and extends to the diamond shaped head of the dragon. The legs are dim stars connected to the body of the dragon. None of the stars are very bright, so look closely. Draco is high in the evening skies of summer and low in the northern winter skies.



Name_____

HANDOUT #B-9 "DRACO, THE DRAGON" PAGE 2

MYTHOLOGY OF DRACO

Draco lived many years ago in the beautiful lush Garden of Hesperides. He grew to be a large strong dragon. He required no sleep and was always awake and moving around. As he grew older the gods noticed that he would make an excellent guard. The gods gave him the duty of defending the Garden of Hesperides.

Hercules lived far away but heard many stories of the Garden of Hesperides. He longed to taste the juicy luscious fruit. The crisp red apples sounded especially good. When Hercules reached manhood, he was very strong and agile. Many feared his strength and courage.

Hercules decided to pursue his life goal of tasting the forbidden fruit of Hesperides. He spent many days traveling to the garden. Upon arriving nearby Hercules ate and slept well because he knew the next day the battle with Draco would begin. The next morning Hercules entered the garden, and Draco immediately challenged his entrance. Hercules drew his sword, and the battle raged for several days and nights. Finally Hercules struck a mortal blow with his sword, and Draco fell dead.

Hercules collapsed and slept for days. When he awoke he ate a juicy red apple. He respected Draco very much for his brave fierce battle. Draco was placed in the night sky as a tribute to his valor and courage.

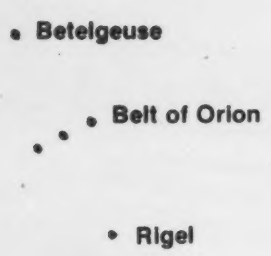
Name_____

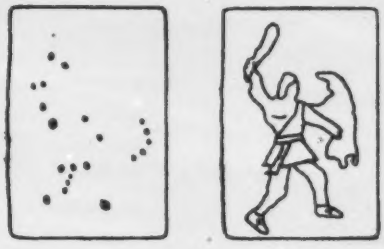
HANDOUT #B-10 "ORION, THE HUNTER"

Orion (O-rían), the Hunter can be found in the southern sky throughout the winter. In December, look for it in the southeast after 9:00 p.m. In February look due south from 7:00 p.m. to 9:00 p.m. In April, look in the southwest immediately after sunset.

To find Orion, look for Betelgeuse (Beetle juice) and Rigel (Ri-jel), the two brightest stars with the three fainter stars of the belt halfway between the two. If you look closely, Betelgeuse has a red color, and Rigel is blue. Betelgeuse is higher in the sky than Rigel.

When you find the basic shape, look for the detail of Orion in fainter stars close by. Orion is standing in the sky facing us. Betelgeuse is his right shoulder. Rigel is his left foot. Look for his left shoulder and right foot to complete the main part of his body. A faint dagger hangs from his belt. His left arm is extended, and he is holding a lion's skin. Holding a club, his right arm extends up from Betelgeuse.





MYTHOLOGY OF ORION

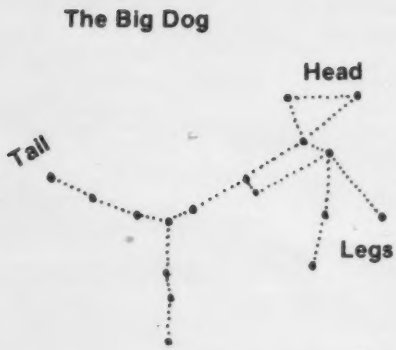
Orion is said to be the most magnificent of the constellations. It is unmistakable in the southern winter sky. To the Greeks, Orion was the ideal hunter. He bragged that he was "the greatest", and there was no animal he could not kill. This made Scorpius angry, so he proceeded to kill Orion. Diana, who was herself a great huntress, persuaded Jupiter to place Orion in the sky. Of course, they put him as far from Scorpius as possible. This is said to be the reason Orion sets when Scorpius rises.

The middle star in Orion's sword is a little fuzzy to the naked eye. The telescope shows us that it is actually a nebula, a sort of cosmic dust cloud. It is one of the few nebula visible to the naked eye and is the center of a vast area of nebulous matter, a series of cosmic dust clouds illuminated by neighboring stars.

Name_____

HANDOUT #B-11 "CANIS MAJOR"

Canis Major (Kā'-nis mā'-jer). The Big Dog has the brightest star in the sky as part of its grouping. An imaginary line drawn from Orion's belt points to Sirius, the brightest star in the sky. Sirius is the heart of the Big Dog. Once you find it, look for the legs and head to complete the picture. Canis Major, one of Orion's hunting dogs, is facing his master to the west.



MYTHOLOGY OF CANIS MAJOR

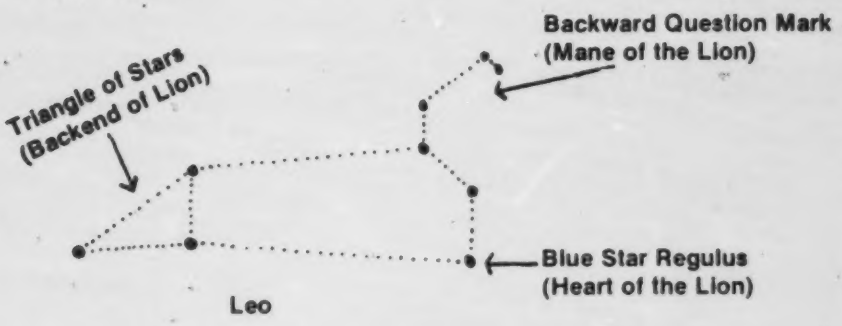
It is believed that this constellation was first perceived by the Eygptians. They associated its rising with the swelling of the Nile, and named the constellation Sirius which represented a big dog. They observed that when Sirius became visible in the east just before the dawn, the overflowing of the Nile immediately followed.

Name_____

HANDOUT #B-12 "LEO, THE LION"

Leo, the Lion can be found in the evening skies of spring. During late March, look high in the eastern sky from 8:00 p.m. to 10:00 p.m. In April Leo is almost directly overhead from sunset until 11:00 p.m. In May Leo is very high in the western sky. Look low in the western sky immediately after sunset to locate Leo in June.

Remember two shapes when looking for the lion. A backward question mark or sickle forms the mane of the lion. The dot of the backward question mark is the bright blue star, Regulus. Southeast of the backward question mark are three stars which form a triangle. These make up the back end of the lion. No stars represent Leo's face or legs, so be sure to use your imagination to add the rest. Leo appears to be standing on his tail early in the evening when he first appears or rises; as the night passes towards morning, he rotates and appears to stand on his head.



MYTHOLOGY OF LEO

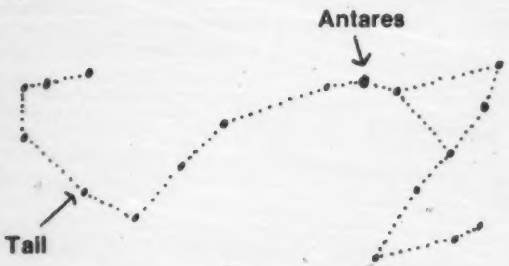
Mythology states that thousands of years ago the sun was in Leo in mid-summer. Leo and the flaming star, Regulus, were associated with the great heat that ancient people endured because their countries are near the tropics. It was obvious that the sun was the brightest and most important of all the heavenly bodies and that the lion was the most powerful of all the animals. So it was natural that they should be associated.

Name_____

HANDOUT #B-13 "SCORPIUS"

Scorpius (Skor'-pi-us). The Scorpion can be located during the summer low in the southern sky. In late June look in the southeastern part of the sky after 10:00 p.m. (Daylight Savings Time). In July look due south between 9:00 p.m. and 11:00 p.m. (DST). In August look in the southwestern sky immediately after sunset.

To find the Scorpion, look for the bright red star named Antares (An-tar'-ez). Antares means "the rival of Mars", and was named for its bright red color. Antares will be low in the southern sky. Antares is the heart of the Scorpion. The tail curves back to the southeast from Antares. Scorpius, the Scorpion is easily recognizable by its shape. Just be sure to look low in the sky.



Name_____

HANDOUT #B-13 "SCORPIUS" PAGE 2

MYTHOLOGY OF SCORPIUS

Scorpius was considered the most deadly prey of man. His sting would bring death to a hunter almost immediately; therefore, all hunters feared Scorpius. He roamed the Earth free of trouble from man or beast.

The great warrior Orion was the most famous hunter of all ages. He traveled the whole Earth, swiftly and surely capturing all his prey. He was very proud of his accomplishments and bragged loudly of his tremendous skill. One night he exclaimed to a gathering of fellow hunters, "There is no greater hunter than I, not even the gods." The gods heard this and became angry with Orion because of his vanity.

The gods decided to challenge Orion with the most feared animal on Earth, Scorpius. A few days later Orion was walking along a road feeling very sure of himself. Down the road the Scorpion crawled from behind a large tree. When Orion saw Scorpius he immediately drew his sword and the battle began. It raged for days. Finally, the Scorpion's tail moved in swiftly and stung Orion's foot. At the same time Orion's sword pierced the shell of Scorpius and cut through to his heart. Both Orion and Scorpius lay dead.

The gods came upon the scene and decided to honor both great warriors. They put Orion in the winter sky and Scorpius in the summer sky so they would never fight again.

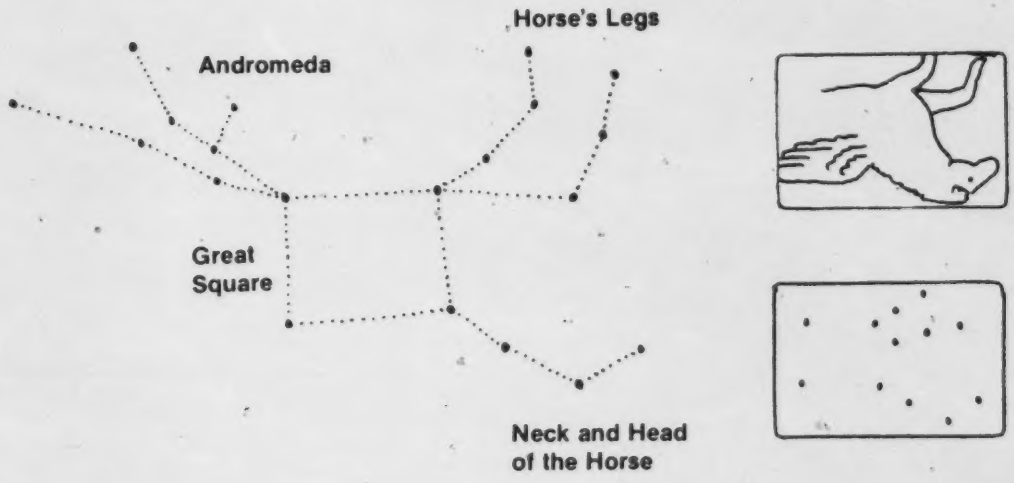
Name_____

HANDOUT #B-14 "PEGASUS, THE WINGED HORSE"

Pegasus (Peg-e-ses). Pegasus is easily seen in the autumn evening skies. In September look halfway up in the eastern sky between 9:00 p.m. and 11:00 p.m. In October look directly overhead from sunset to 11:00 p.m. In November and December look directly overhead from sunset to 10:00 p.m. In January look in the western sky after sunset.

When searching for the winged horse the shape to look for is the "Great Square of Pegasus." The Great Square is very large and made up of four fairly bright stars, which form the body of the winged horse. Pegasus is upside down in the sky. The head extends out from the body to the southwest. The front legs extend to the northwest. The beautiful maiden Andromeda, a galaxy, shares the northeastern star of the Great Square with Pegasus.

Be sure to use your imagination to add the back portion of the horse and the wings.



Name_____

HANDOUT #B-14 "PEGASUS, THE WINGED HORSE" PAGE 2

MYTHOLOGY OF PEGASUS

When a Greek hero cut off the head of the snake-haired witch, Medusa; Pegasus, the beautiful white-winged horse sprang from the oozing blood of the neck. In spite of a horrible beginning Pegasus was a beautiful but wild horse.

Pegasus would often land in lovely, lush, green meadows to graze. If anyone came close,the horse would fly into the sky. Bellerophon (Bel-air-e-fon) was a strong young Greek boy. He wanted more than anything else to become famous. He tried to catch Pegasus but never could. One night he had a dream. In the dream a goddess gave him a golden bridle to tame the beautiful winged horse. The next morning he woke up and found the beautiful bridle beside him.

When he saw Pegasus grazing quietly in a meadow, he walked up to him slowly with the golden bridle. The white horse did not fly away. He placed the bridle on Pegasus and jumped on his back. Pegasus bolted into the air, and they flew far and wide. Bellerophon and Pegasus became the best of friends. Bellerophon felt strong and sure of himself. He became very famous. With Pegasus underneath him, Bellerophon accomplished many difficult tasks. The hardest task was killing the horrible monster named the Chimera (Chi-mer-a). The Chimera had a lion's head, a goat's body, and a dragon's tail.

One day Bellerophon was feeling very proud of himself, so proud in fact, that he decided to fly to the top of Mount Olympus, the home of the gods. Going to Mount Olympus was strictly forbidden by the gods. Bellerophon and Pegasus flew higher and higher. Pegasus knew he should not fly so high. Pegasus became nervous when a large fly stung him. He bucked Bellerophon off his back. Pegasus kept on flying higher and higher until he reached his present place in the night skies. Bellerophon died a crippled unknown beggar while lost somewhere on the Earth.

Name_____

HANDOUT #B-15 SIMPLIFIED CONSTELLATION SKY MAP (STUDENT)

APPENDIX C

A PLANETARIUM

PLANETARIUM ORIENTATION

A planetarium is a device which simulates the night sky indoors. The typical planetarium consists of a dome-shaped ceiling which acts as a screen and a projector which produces an image of the stars (and sometimes other celestial bodies) on the dome-shaped ceiling. The first planetariums constructed in the United States were opened to the public in the early 1930's.

Educators have long recognized the value of planetariums in teaching astronomy concepts. Planetariums have the advantage of being able to compress time. Such things as the nightly motion of the stars and seasonal changes in the stars can be demonstrated to an entire class in one session. There are never clouds or weather problems in a planetarium. Many planetariums can project lines to outline constellations, and mark points of reference such as the celestial equator, celestial north pole, the ecliptic, and the zodiac.

The planetarium field has undergone vast improvements in technology during the past few decades. New dome construction techniques using prefabricated aluminum and fiberglass, and application of mass production techniques to projector manufacture have made the planetarium available to institutions of higher education, museums, and larger public school districts. A comparatively recent development has been the inflatable planetarium which is completely portable. These planetariums accomodate one class and can be set up in a few minutes in a gym, multipurpose room, or other area with a high ceiling. This type of planetarium has been purchased by several Educational Service Units and school districts.

At this point a word of caution might be in order. Many children (and some teachers) confuse planetariums with observatories. An observatory is a building which houses a telescope (or telescopes). Many observatories have a dome-shaped roof with an opening for the telescope to look through, but this is the only resemblance in appearance or function between observatories and planetariums.

APPENDIX D

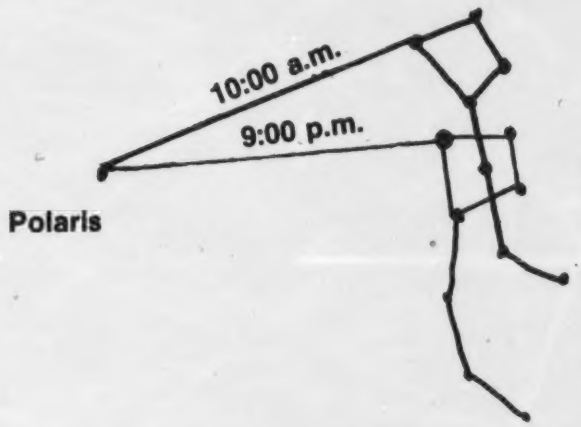
MOTION

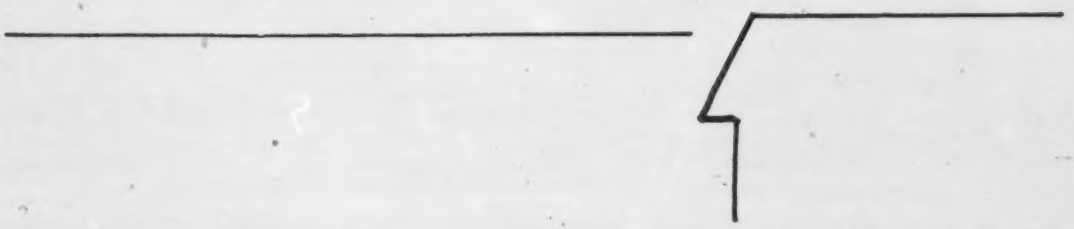
Name_____

HANDOUT #D-1 "THE BIG DIPPER IS A MOVER."

This is an activity requiring a great deal of time. Begin after sundown as soon as you can locate the Big Dipper. Orient this diagram so that the dipper is sitting in the location just like the actual constellation. Draw the dipper on this page and record the exact time. (Example: 7:42 p.m.) Return exactly one hour later, draw the dipper in its <u>new</u> location, and again record the time.

Repeat this observation/recording process two more times so that you have recorded four different observations.





APPENDIX E

NIGHT SKY PARTY

Name_____

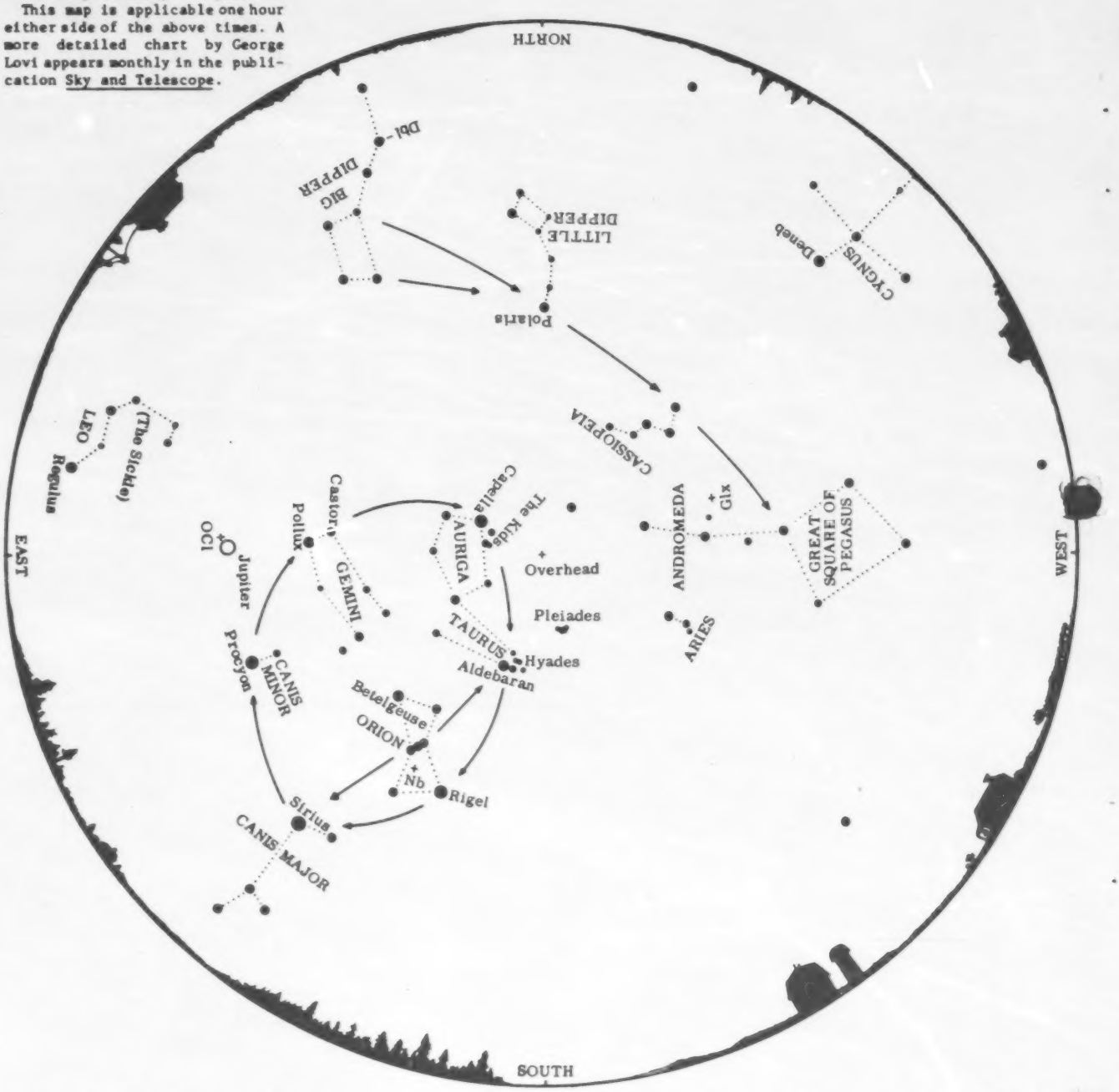
HANDOUT #E-1 "SIMPLIFIED STAR CHART"

January Evening Skies

This chart is drawn for Latitude 40° North, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local standard times:

Late December	10 p.m.
Early January	9 p.m.
Late January	8 p.m.
Early February	7 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.



The planet Jupiter is plotted for mid-January, 1979. At chart time 10 objects of first magnitude or brighter are visible. In order of brightness they are: Jupiter, Sirius, Capella, Rigel, Procyon, Betelgeuse, Aldebaran, Pollux, Deneb, and Regulus.

In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Db1) at the bend of the handle of the Big Dipper is easily detected. The famous Orion Nebula, a cloud of gas and dust out of which stars are forming, is marked (Nb) in that constellation. The open or galactic star cluster (OC1) known as the "Beehive" can be located between the Gemini twins and Leo. The position of an external star system, called the Andromeda Galaxy after the constellation in which it appears, is also indicated (Glx). Try to observe these objects with unaided eye and binoculars.

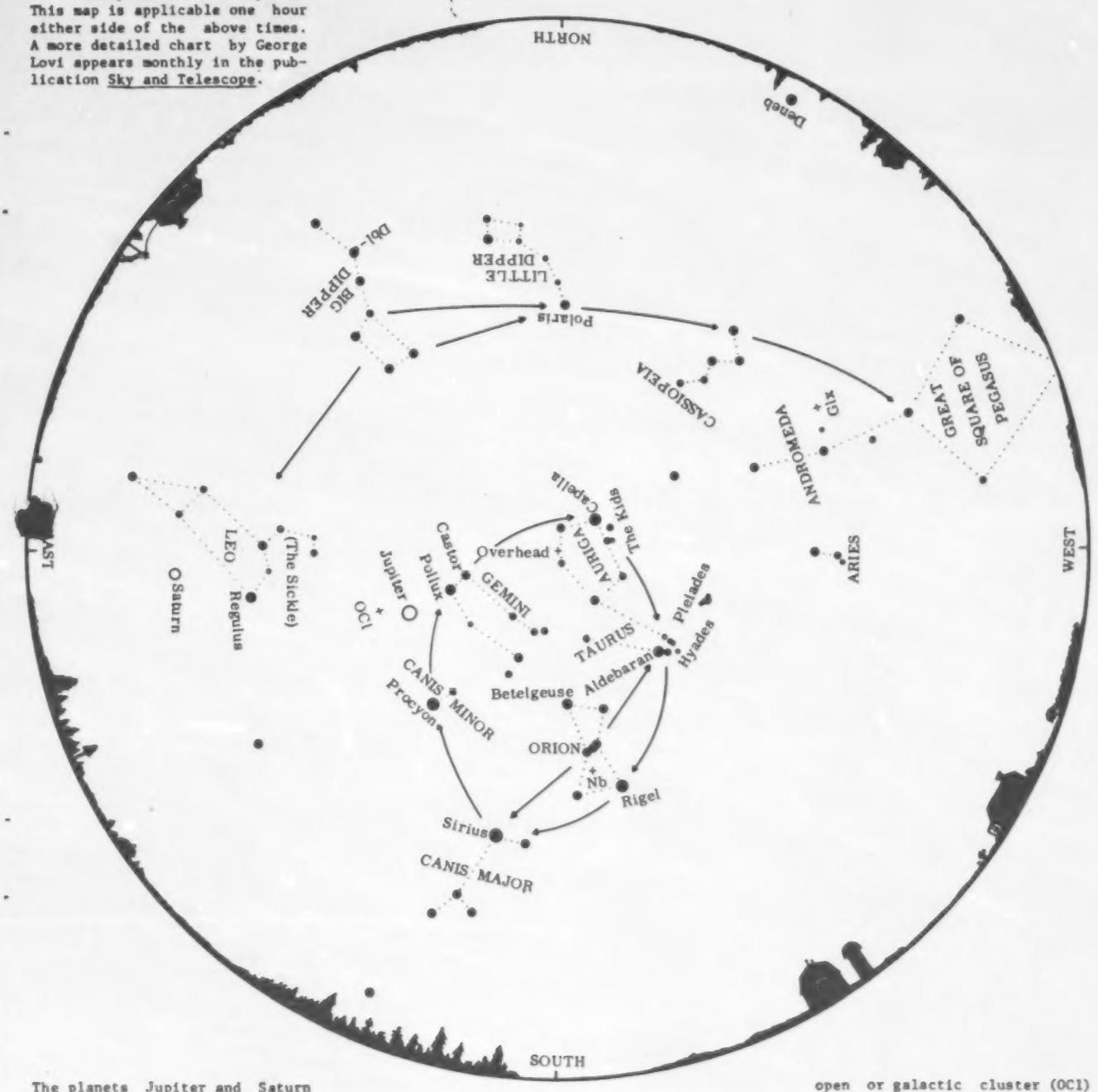
--D. David Batch

February Evening Skies

This chart is drawn for Latitude 40° North, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local times:

Late January	10 p.m.
Early February	9 p.m.
Late February	8 p.m.
Early March	7 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.



The planets Jupiter and Saturn are plotted for mid-February, 1979. At chart time 11 objects of first magnitude or brighter are visible. In order of brightness they are: Jupiter, Sirius, Capella, Rigel, Saturn, Procyon, Betelgeuse, Aldebaran, Pollux, Deneb, and Regulus.

In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Dbl) at the bend of the handle of the Big Dipper is easily detected. The famous Orion Nebula, a cloud of gas and dust out of which stars are forming, is marked (Nb) in that constellation. The open or galactic cluster (OCl) known as the "Beehive" can be located between the Gemini twins and Leo. The position of an external star system, called the Andromeda Galaxy after the constellation in which it appears, is also indicated (Glx). Try to observe these objects with unaided eye and binoculars.

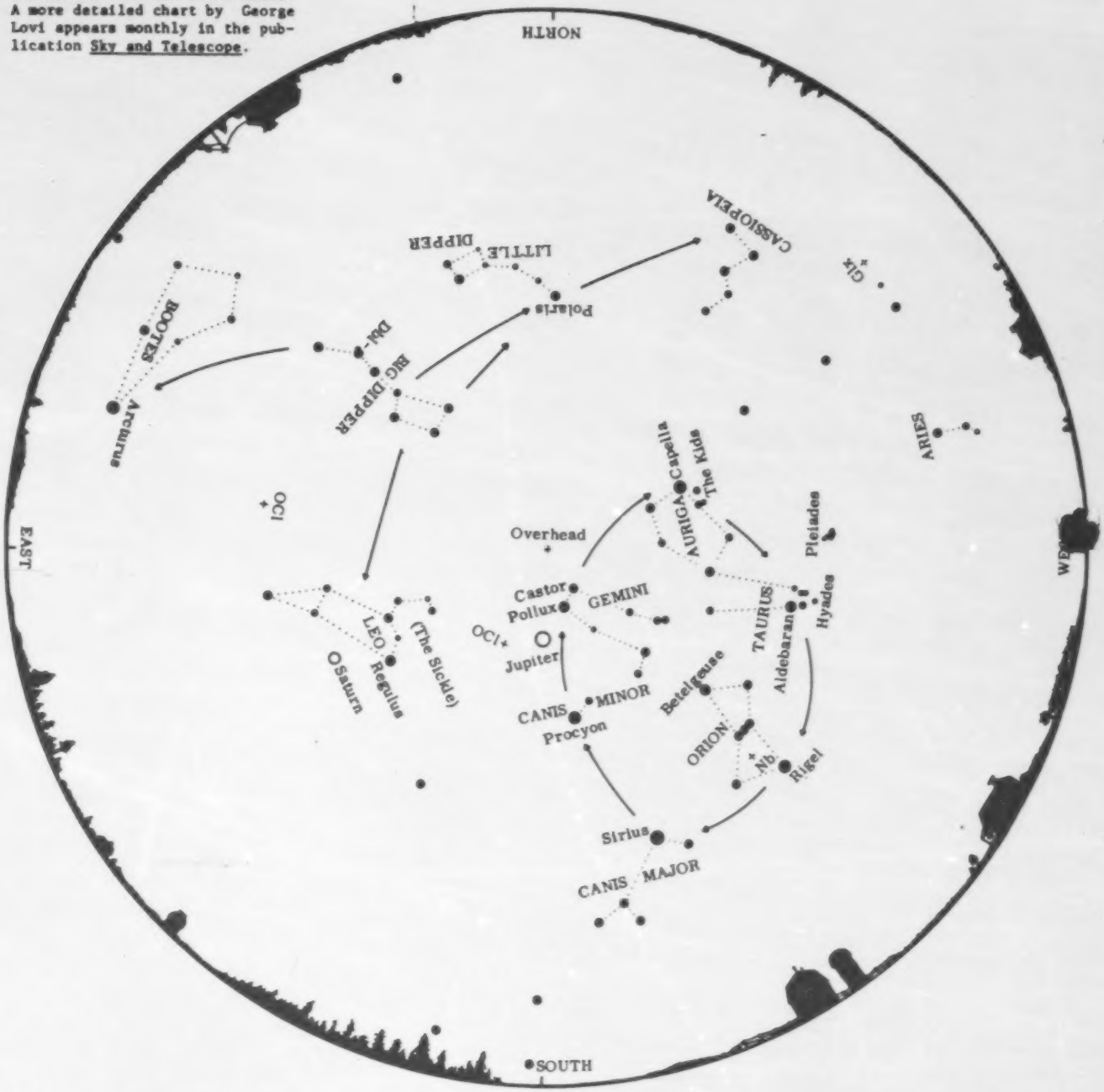
—D. David Batch

March Evening Skies

This chart is drawn for Latitude 40° North, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local times:

Late February	10 p.m.
Early March	9 p.m.
Late March	8 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.



The planets Jupiter and Saturn are plotted for mid-March, 1979. At chart time 11 objects of first magnitude or brighter are visible. In order of brightness they are: Jupiter, Sirius, Arcturus, Capella, Rigel, Saturn, Procyon, Betelgeuse, Aldebaran, Pollux, and Regulus.

In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Dbl) at the bend of the handle of the Big Dipper is easily detected. The famous Orion Nebula, a cloud of gas and dust out of which stars are forming, is marked (Nb) in that constellation. The open or galactic cluster (OCl) known as the "Beehive" can be located between the Gemini twins and Leo.

Coma Berenices, "The hair of Berenice", is another open cluster (OCl), between Leo and Boo[illegible]. The position of an external star system, called the Andromeda Galaxy after the constellation in which it appears, is also indicated (Glx). Try to observe these objects with unaided eye and binoculars.

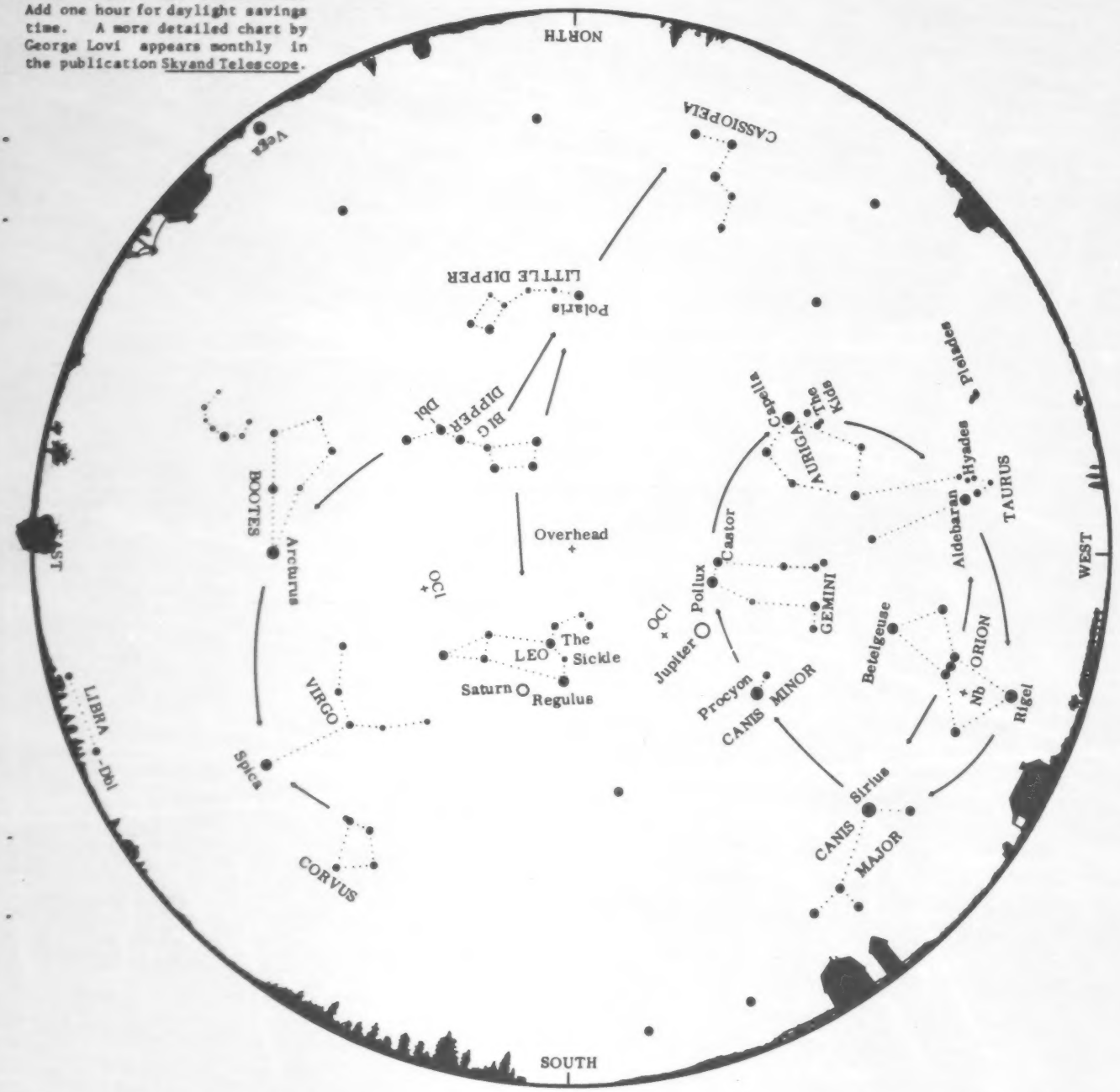
--D. David Batch

April Evening Skies

This chart is drawn for Latitude 40° North, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local times:

Late March	10 p.m.
Early April	9 p.m.
Late April	8 p.m.

This map is applicable one hour either side of the above times. Add one hour for daylight savings time. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.



The planets Jupiter and Saturn are plotted for mid-April, 1979. For chart time 13 objects of first magnitude or brighter are visible. In order of brightness they are: Jupiter, Sirius, Arcturus, Vega, Capella, Rigel, Procyon, Saturn, Betelgeuse, Aldebaran, Spica, Pollux, and Regulus.

In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Dbl) at the bend of the handle of the Big Dipper is easily detected. The famous Orion Nebula, a cloud of gas and dust out of which stars are forming, is marked (Nb) in that constellation. The open or galactic cluster (OCl) known as the "Beehive" can be located between the Gemini twins and Leo. Coma Berenices, "The hair of Berenice", is another open cluster (OCl), between Leo and Bootes. Try to observe these objects with unaided eye and binoculars.

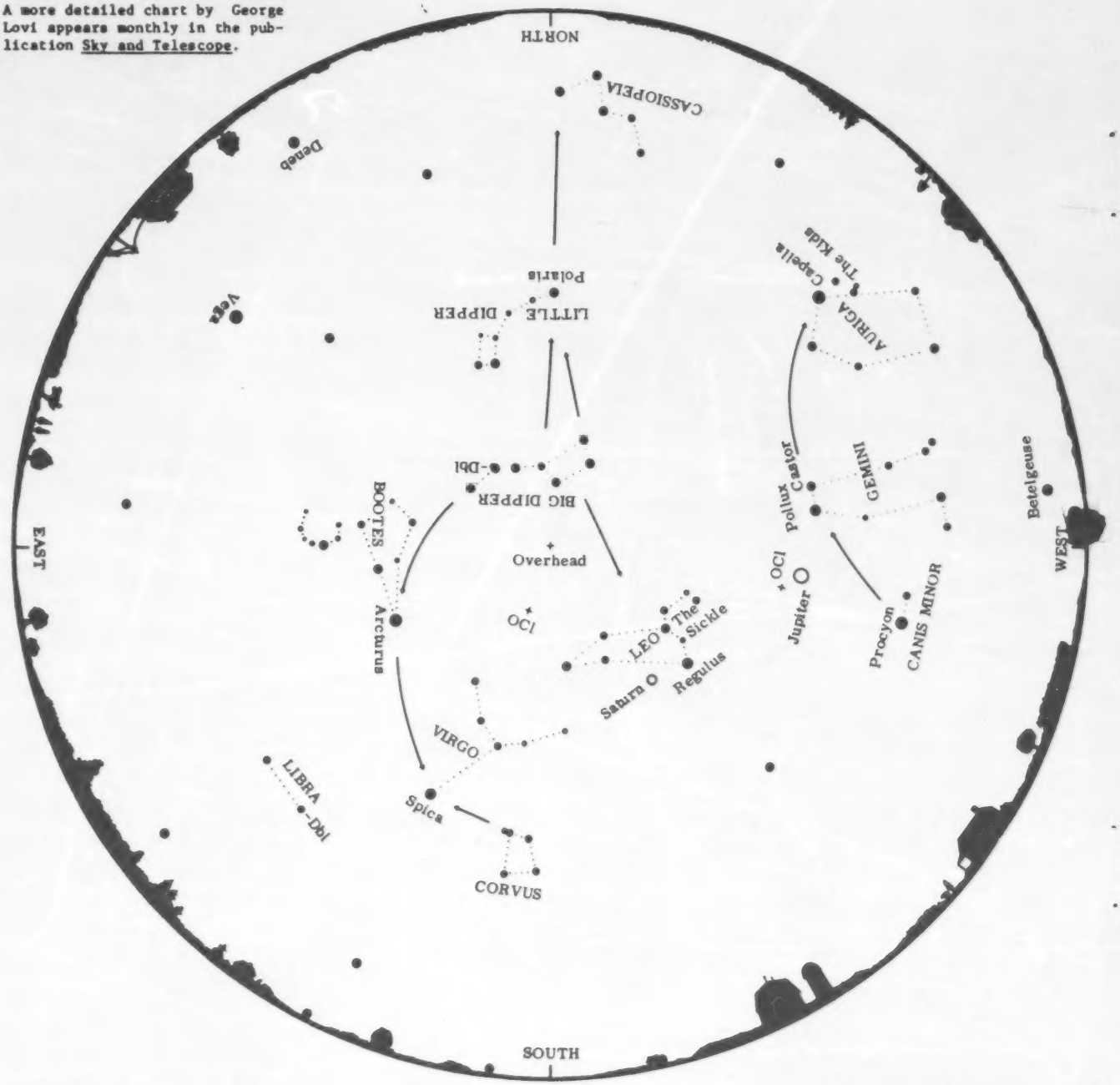
--D. David Batch

May Evening Skies 76

This chart is drawn for Latitude 40° north, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local daylight times:

Late April	11 p.m.
Early May	10 p.m.
Late May	9 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.

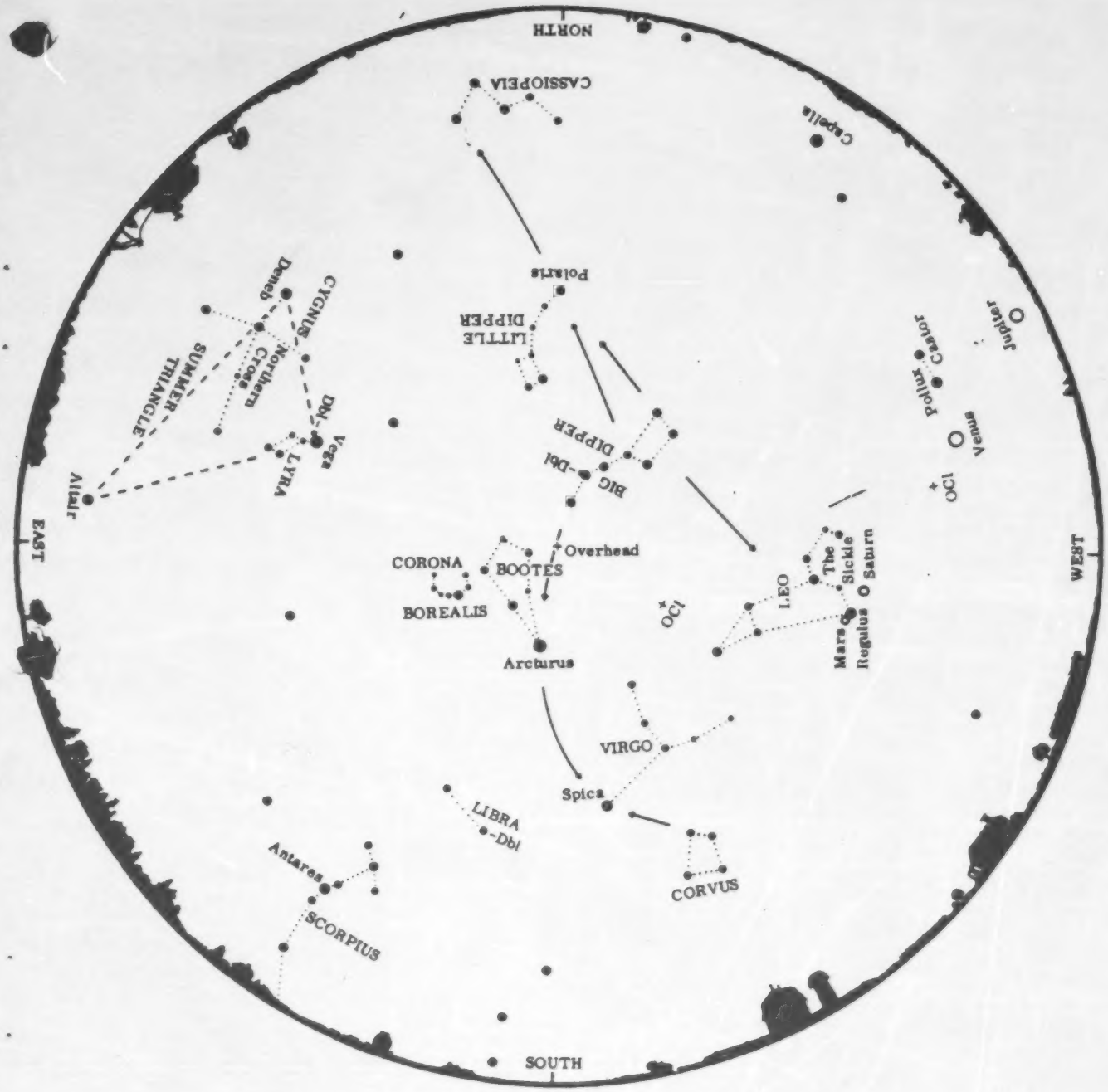


The planets Jupiter and Saturn are plotted for mid-May, 1979. At chart time 11 objects of first magnitude or brighter are visible. In order of brightness they are: Jupiter, Arcturus, Vega, Capella, Procyon, Saturn, Betelgeuse, Spica, Pollux, Deneb, and Regulus.

In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Dbl) at the bend of the handle of the Big Dipper is easily detected. The open or galactic cluster (OCl) known as the "Beehive" can be located between the Gemini twins and Leo. Coma Berenices, "The hair of Berenice", is another open cluster (OCl), between Leo and Bootes. Try to observe these objects with unaided eye and binoculars.

--D. David Batch

June Evening Skies



This chart is drawn for latitude 40° North, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local daylight times:

Late May	11 p.m.
Early June	10 p.m.
Late June	9 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.

The planets Venus, Jupiter, Saturn, and Mars are plotted for mid-June. At chart time 12 objects of first magnitude or brighter are visible. In order of brightness they are: Venus, Jupiter, Arcturus, Vega, Capella, Altair, Saturn, Antares, Spica, Pollux, Deneb, and Regulus.

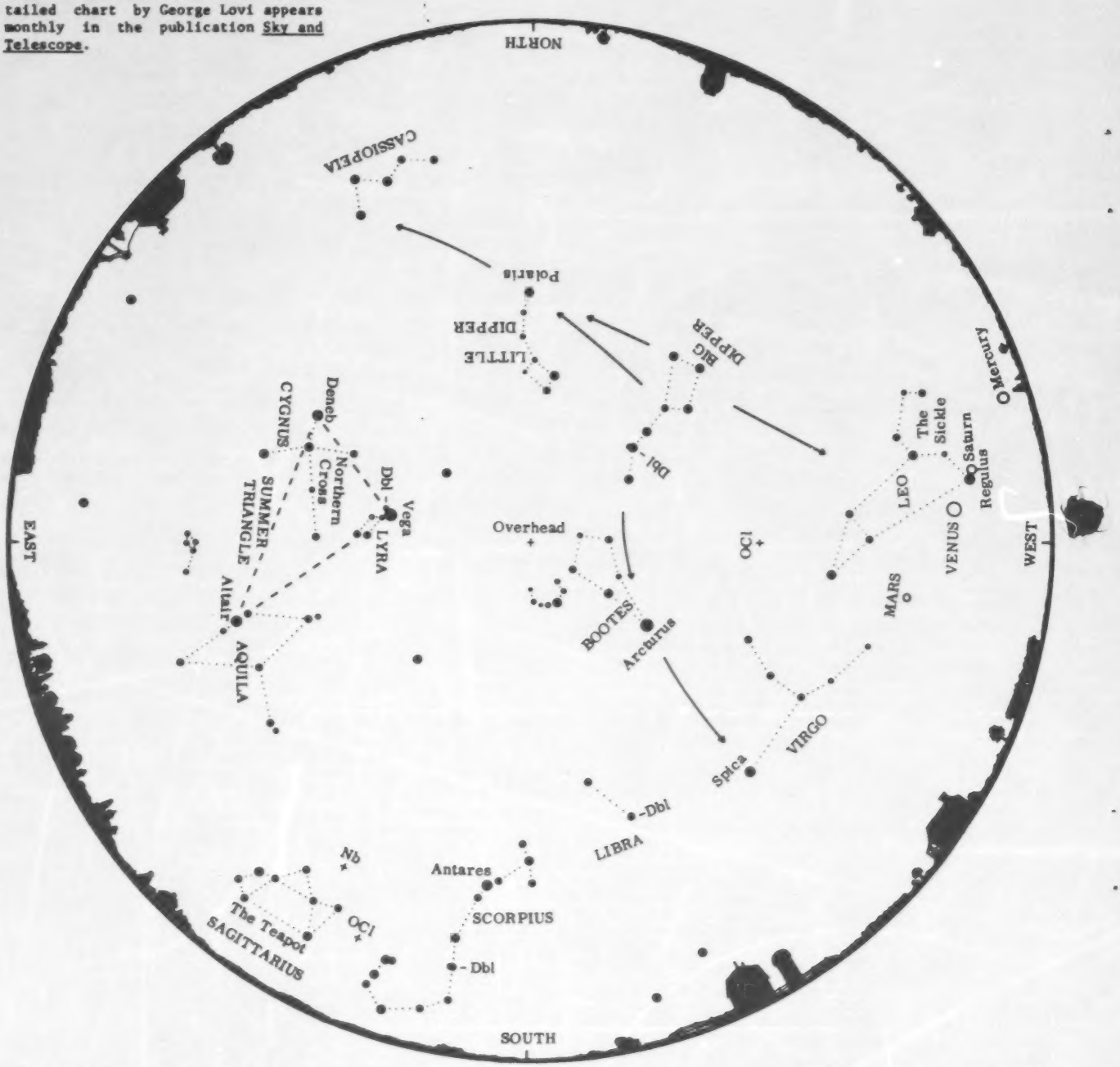
In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Dbl) at the bend of the handle of the Big Dipper is easily detected. The double in Libra is more challenging. Much more difficult is the double star near Vega. The open or galactic cluster (OCl) known as the "Beehive" can be located between the Gemini twins (Pollux and Castor) and Leo. Coma Berenices, "The hair of Berenice," is another open cluster (OCl) between Leo and Bootes. Try to observe these objects with unaided eye and binoculars.

July Evening Skies

This chart is drawn for Latitude 40° north, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local daylight times:

Late June	11 p.m.
Early July	10 p.m.
Late July	9 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.



The planets Venus, Mercury, Saturn, and Mars are plotted for mid-July, 1978. At chart time 10 objects of first magnitude or brighter are visible. In order of brightness they are: Venus, Arcturus, Vega, Mercury, Altair, Saturn, Antares, Spica, Deneb, and Regulus.

In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Dbl) at the bend of the handle of the Big Dipper is easily detected. The double star in Scorpius is somewhat harder. Much more difficult is the double star near Vega in Lyra. The open or galactic cluster (OCl) known as Coma Berenices, "the hair of Berenice," is located between Leo and Boötes. A more compact open cluster is located between Sagittarius and the "tail" of Scorpius. Nearby, marked (Nb) above the "spout" of the "teapot," is the Lagoon Nebula, a cloud of gas and dust out of which stars are forming. Try to observe these objects with unaided eye and binoculars.

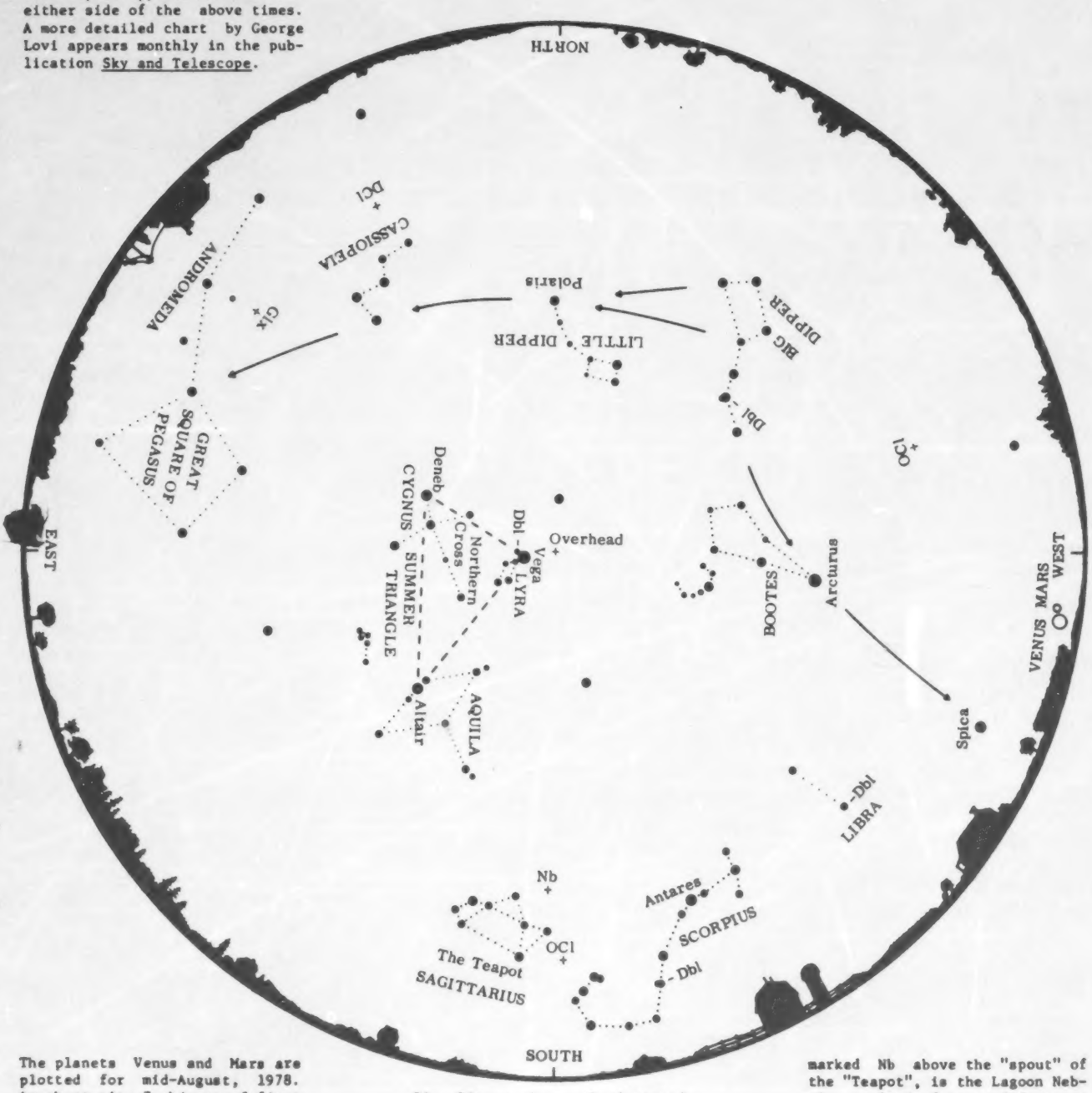
--D. David Batch

August Evening Skies

This chart is drawn for Latitude 40° north, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local daylight times:

Late July	11 p.m.
Early August	10 p.m.
Late August	9 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.



The planets Venus and Mars are plotted for mid-August, 1978. At chart time 7 objects of first magnitude or brighter are visible. In order of brightness they are: Venus, Arcturus, Vega, Altair, Antares, Spica, and Deneb.

In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Dbl) at the bend of the handle of the Big Dipper is easily detected. The double star in Scorpius is somewhat harder. Much more difficult is the double star near Vega in Lyra. The open or galactic cluster (OCl) known as Coma Berenices, "The hair of Berenice", is located between Leo and Boötes. A more compact open cluster is located between Sagittarius and the "tail" of Scorpius. Nearby, marked Nb above the "spout" of the "Teapot", is the Lagoon Nebula, a cloud of gas and dust out of which stars are forming. The position of an external star system, called the Andromeda Galaxy after the constellation in which it appears, is also indicated (Glx). Try to observe these objects with unaided eye and binoculars.

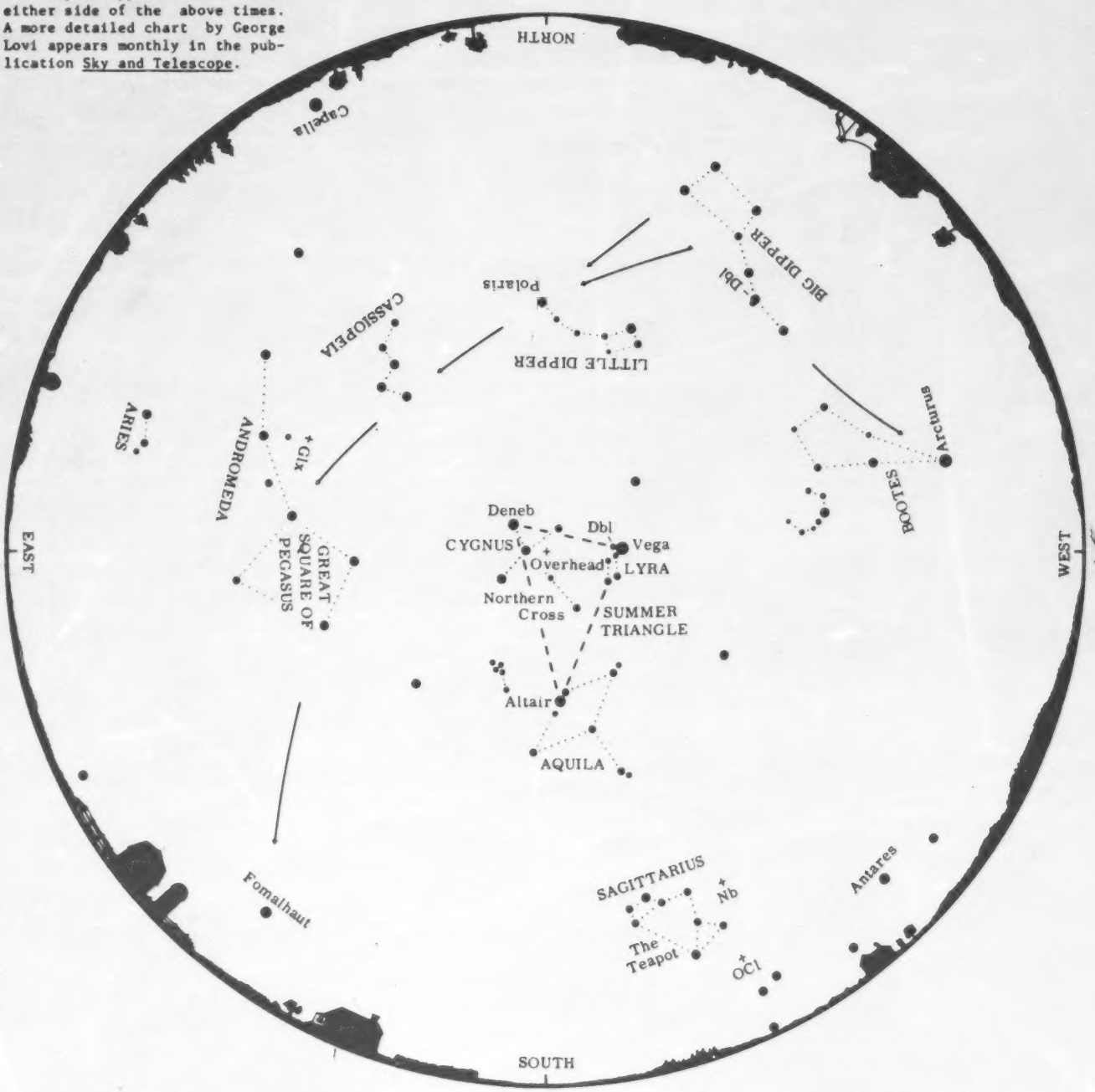
--D. David Batch

September Evening Skies 80

This chart is drawn for Latitude 40° north, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local daylight times:

Late August 11 p.m.
Early September 10 p.m.
Late September 9 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.



The planets are not plotted on this map. Check the Sky Calendar for planet visibilities. At chart time 7 objects of first magnitude or brighter are visible. In order of brightness they are: Arcturus, Vega, Capella, Altair, Antares, Fomalhaut, and Deneb.

In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Dbl) at the bend of the handle of the Big Dipper is easily detected. Much more difficult is the double star near Vega in Lyra. An open or galactic star cluster (OCl) located below Sagittarius, low in the south-southwest, will challenge the unaided eye. Nearby, marked Nb above the "spout" of the "Teapot", is the Lagoon Nebula, a cloud of gas and dust out of which stars are forming. The position of an external star system, called the Andromeda Galaxy after the constellation in which it appears, is also indicated (Glx). Try to observe these objects with unaided eye and binoculars.

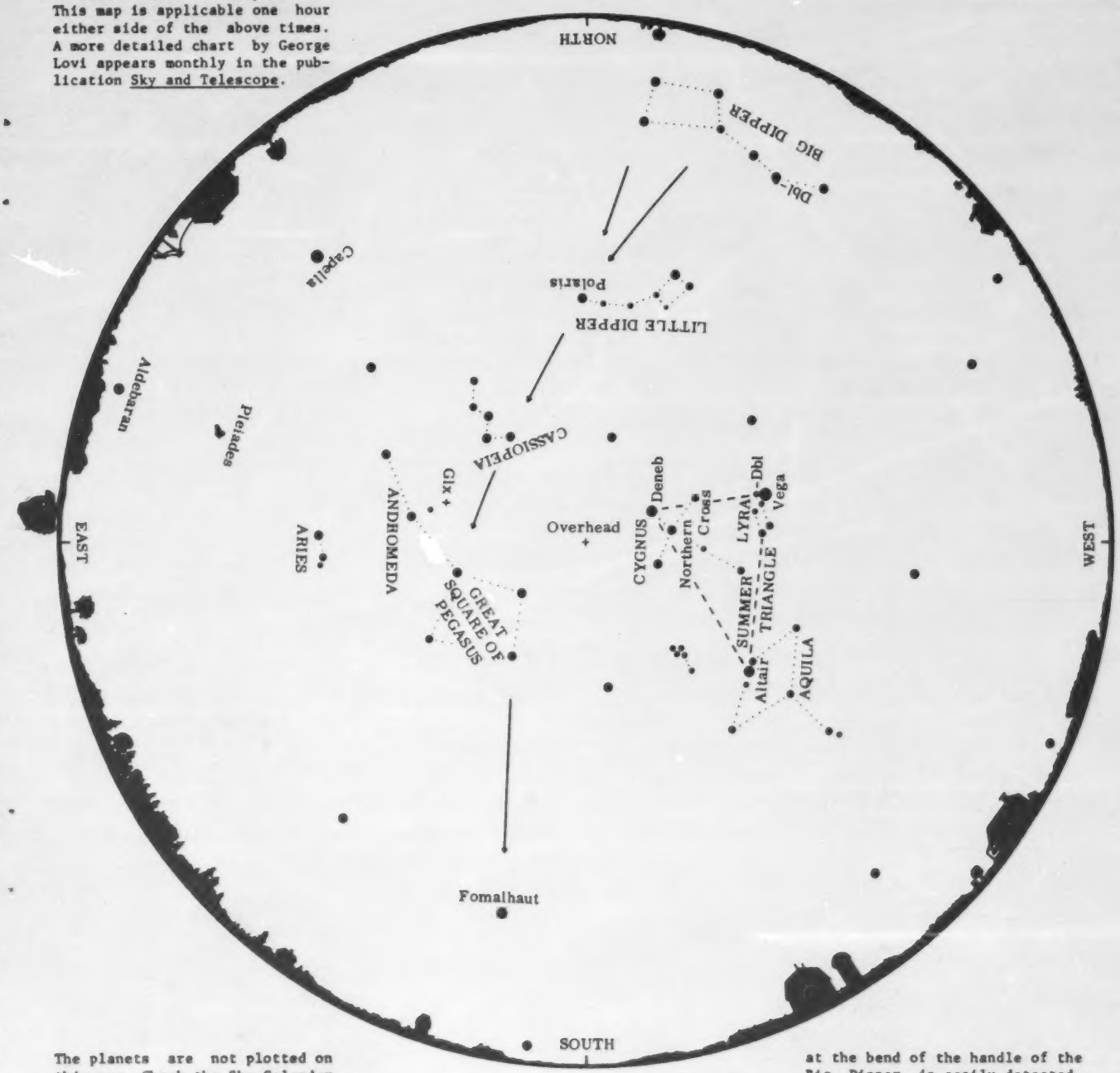
--D. David Batch

October Evening Skies

This chart is drawn for Latitude 40° north, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local daylight times:

Late September	11 p.m.
Early October	10 p.m.
Late October	9 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.



The planets are not plotted on this map. Check the Sky Calendar for planet visibilities. At chart time 6 objects of first magnitude or brighter are visible. In order of brightness they are: Vega, Capella, Altair, Aldebaran, Fomalhaut, and Deneb.

In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Dbl) at the bend of the handle of the Big Dipper is easily detected. Much more difficult is the double star near Vega in Lyra. The position of an external star system, called the Andromeda Galaxy after the constellation in which it appears, is also indicated (Glx). Try to observe these objects with unaided eye and binoculars.

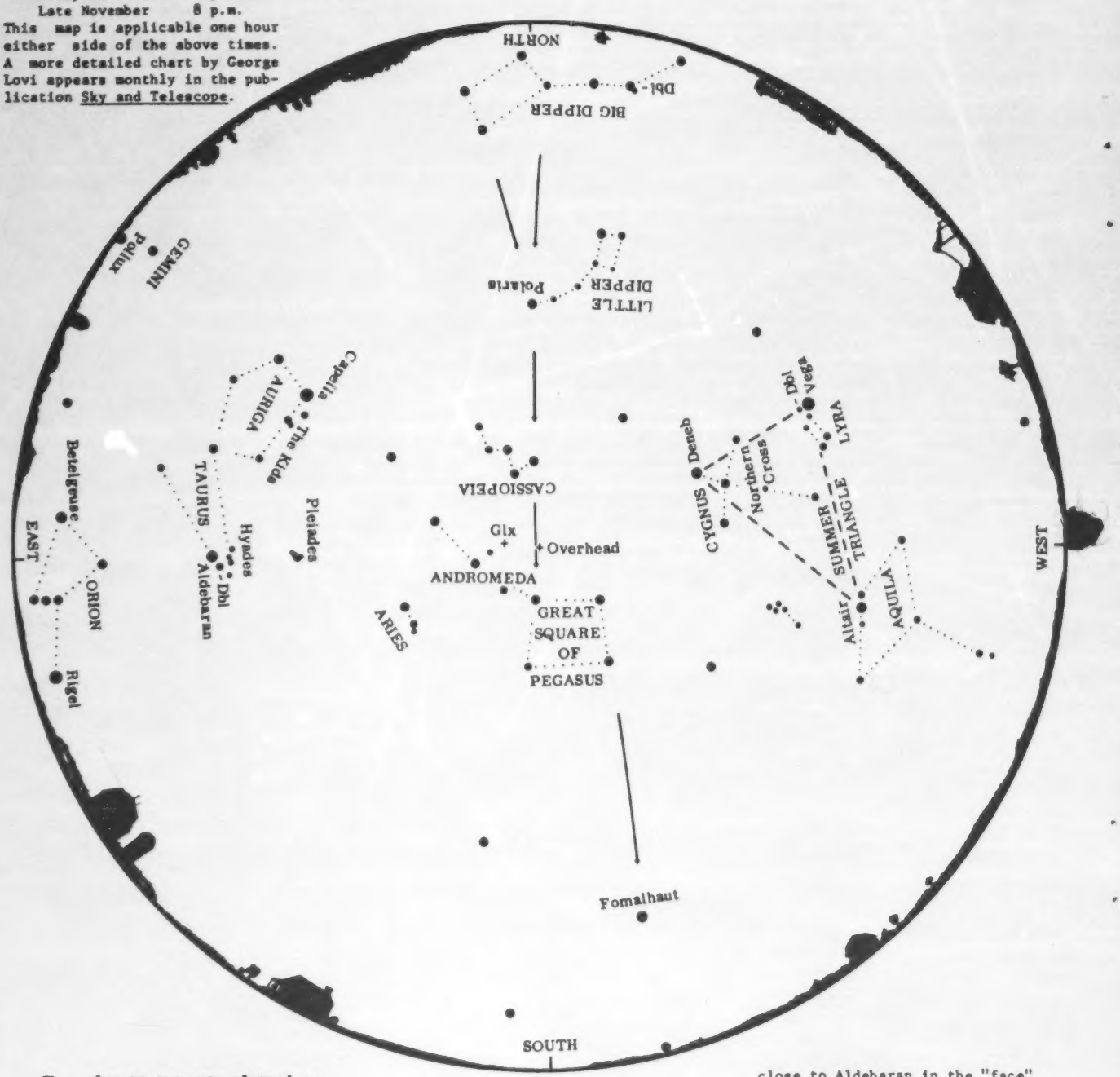
--D. David Batch

November Evening Skies 82

This chart is drawn for Latitude 40° north, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local standard times:

Late October	10 p.m.
Early November	9 p.m.
Late November	8 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.



The planets are not plotted on this map. Check the Sky Calendar for planet visibilities. At chart time 9 objects of first magnitude or brighter are visible. In order of brightness they are: Vega, Capella, Rigel, Betelgeuse, Altair, Aldebaran, Pollux, Fomalhaut, and Deneb. Because of the low altitude of several of the bright stars, their relative brilliance will be diminished, accompanied by increased twinkling.

In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Dbl) at the bend of the handle of the Big Dipper should be detectable low in the north. Another is close to Aldebaran in the "face" of Taurus. More closely spaced is the double star near Vega in Lyra. The position of an external star system, called the Andromeda Galaxy after the constellation in which it appears, is also indicated (Glx). Try to observe these objects with unaided eye and binoculars.

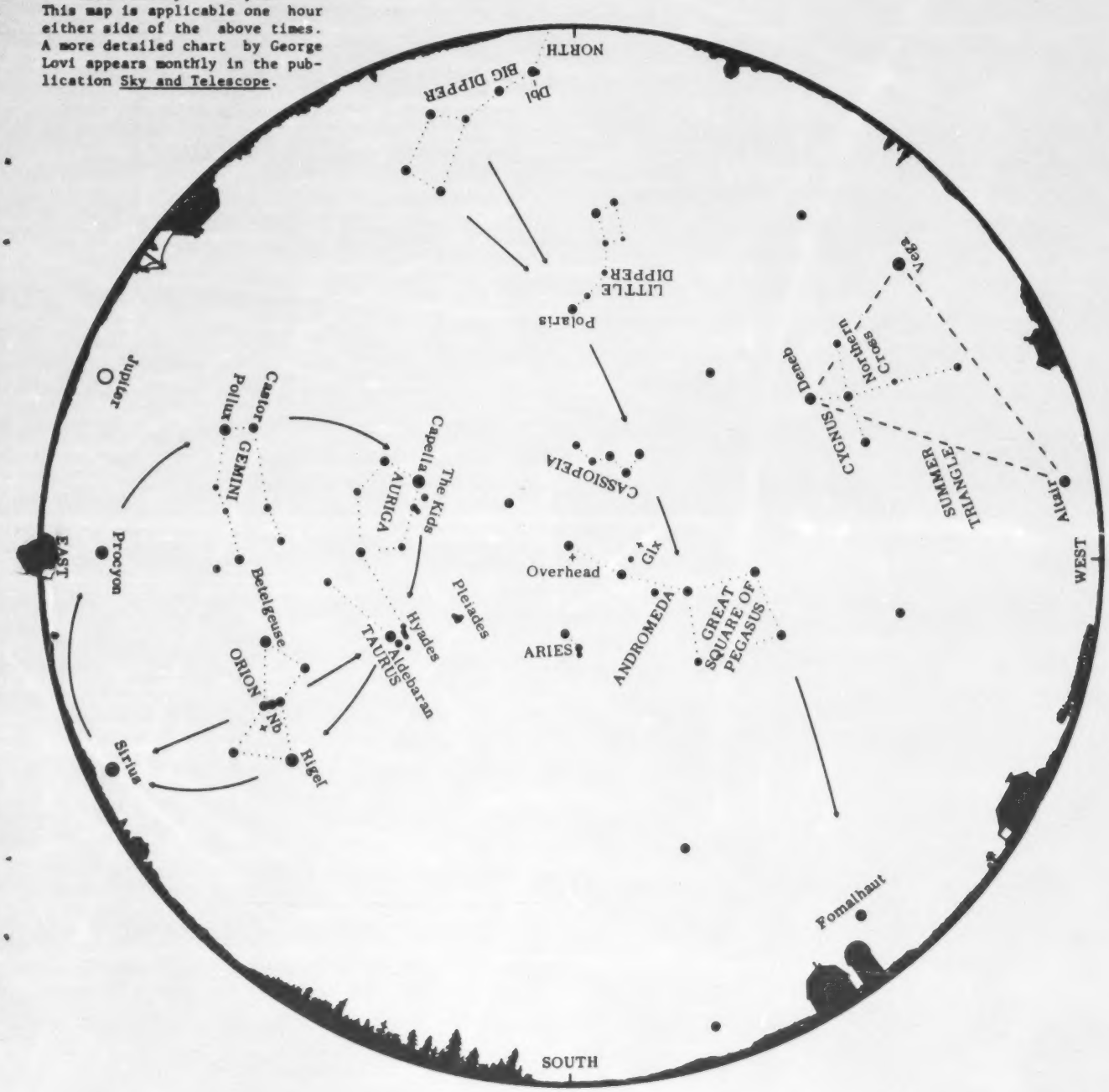
--D. David Batch

December Evening Skies

This chart is drawn for Latitude 40° north, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local standard times:

Late November	10 p.m.
Early December	9 p.m.
Late December	8 p.m.
Early January	7 p.m.
Late January	6 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.



The planet Jupiter is plotted for mid-December, 1978. At chart time 12 objects of first magnitude or brighter are visible. In order of brightness they are: Jupiter, Sirius, Vega, Capella, Rigel, Procyon, Betelgeuse, Altair, Aldebaran, Pollux, Fomalhaut, and Deneb.

In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Dbl) at the bend of the handle of the Big Dipper should be detectable above the treetops in the north. The famous Orion Nebula, a cloud of gas and dust out of which stars are forming, is marked (Nb) in that constellation. The position of an external star system, called the Andromeda Galaxy after the constellation in which it appears, is also indicated (Glx). Try to observe these objects with unaided eye and binoculars.

--D. David Batch

GLOSSARY

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Celestial Equator - The great circle halfway between the celestial poles, corresponding to the equator of the earth on the celestial sphere.

Constellation - A group of stars which form an imaginary figure. Myths and legends are often attached to constellations.

Coriolis Effect - The deflection of moving objects relative to the Earth's surface caused by the the Earth's rotation.

Declination - Imaginary division markers on the celestial sphere which corresponds to latitude on Earth, parallel to the celestial equator.

Double Star (Binary Star) - Two or more stars either physically connected or in the same line of sight, which may appear to the naked eye as a single star.

Ecliptic - The path through the celestial sphere which the sun appears to follow in the course of a year.

Magnitude - A relative scale of brightness. The lower the number, the greater the brightness; the higher the number, the lower the brightness. The brightest bodies have negative magnitudes.

Meteor - Stony or metallic particles which become visible when they enter the Earth's atmosphere and are heated by friction. A meteor completely vaporizes and never strikes the Earth.

Meteorite - A meteor becomes a meteorite if it does not vaporize completely and strikes the Earth.

Nadir - The point which is directly below the zenith.

Nebula - A very faint, luminous patch of dust and gas which either emits or reflects light.

North Celestial Pole (NCP) - The point in the Northern Hemisphere about which the celestial sphere appears to revolve; the zenith at the North Pole on the Earth.

Observatory - A building with movable roof to allow for telescopic observation of the universe.

Planetarium - A building, having a large dome, in which is housed an optical device to project various celestial images and effects on the dome.

GLOSSARY (Continued)

Right Ascension - Imaginary division markers on the celestial sphere which correspond to longitude on the Earth.

South Celestial Pole (SCP) - The point in the Southern Hemisphere about which the celestial sphere appears to revolve; the zenith at the South Pole on the Earth.

Star Cluster - A small group of stars that appear to be more or less closely packed together.

Vernal Equinox - The zero point for celestial measurement of right ascension, where the sun appears to be in the sky about March 21.

Zenith - The point in space directly overhead.

Zodiac - A belt on the celestial sphere, on either side of the ecliptic. It is 16° wide, containing the 12 zodiacal constellations. The moon and the planets travel in this belt.

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